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What the War Has in Store for the Foundry Trade

American Foundrymen Will Be Called Upon to Solve New Problems in Producing Castings for the Government's Huge War Program

READJUSTMENTS in trade were predicted as a natural result of the entry of the United States in the European conflict. The foundry industry already has been affected by these changes, but a survey of the situation indicates that manufacturers of castings have benefitted and the total melt has increased considerably. Almost immediately after the declaration of war, the wave of economy which spread over the country enmeshed the automobile trade and the buying of pleasure cars began to wane. This was passed down the line to the makers of cylinders and other parts for motor vehicles, with the result that the melt in many shops was curtailed as high as 50 per cent.

However, to replace a large part of this business, the government contemplates the purchase of 76,000 motor trucks and the aeroplane program more than promises to offset the loss in tonnage of motor car castings. In this readjustment, consideration must also be given to the heavy requirements of castings of all kinds for field artillery, and the gray iron foundries as well as the steel casting and brass plants have been beneficiaries. Other readjustments in the foundry trade are certain to occur from time to time, and while these may affect some branches of the industry temporarily, the wastage of war will more than compensate for this tonnage.

Cast Iron or Semi-Steel Shells

It was generally believed that our munitions experts would investigate the use of cast iron or semi-steel shells. It has been reported frequently that the Germans are using cast iron, or some similar material for high explosive shells, and the French are employing semi-steel for this purpose. It is doubtful, however, if any immediate progress in this direction is going to be made in this country since the opinion has been expressed that the need for semi-steel for shell purposes does not exist here. In view of this statement it might be advisable to direct attention to the reported economies that may be effected by their use.

According to authoritative advice, the French are employing a bessemer converter metal for this purpose, which is exceedingly low in phosphorus and is difficult to obtain in this country at the present time. Low phosphorus pig iron and scrap constitute the cupola charge which produces metal by blowing in the converter. To this metal, in the ladle, is added one-third converter steel as blown and this constitutes the mixture from which thousands of high explosive shells have been made and are being cast in France.

Shells Cored-Out

These shells are cored-out, eliminating almost entirely the heavy expense and the time-consuming operation of boring by machine. Furthermore, the shells can be made in much less time than is required for producing them in steel. Time is conserved and the cost is greatly reduced, both elements of the greatest importance to us in our preparatory stage. Cast iron, or semi-steel, as it might be termed correctly, as used for shells in France, possesses all of the necessary physical properties for a metal for high explosive shell purposes. Cast iron is the ranking metal in the property of compression, and being brittle, it will shatter better than any other material that may be employed. It lacks elasticity, but this is imparted to it in the necessary amount by the addition of the converter steel. The problem of molding the shells involves no great difficulties and many machines are available that can be adapted for this purpose.

If the French process possesses any merits, these should be investigated in our speeding-up process and a commission should be sent to France to learn the facts. Steel shells are being cast successfully in this country, but these are being bored-out, whereas a large part of this expensive machine work might be eliminated by the judicious use of cores. Even if there are objections to the use of cores, their employment

at least might be investigated. The American Navy, according to reliable reports, has used cast iron shells for practice purposes, and furthermore, these castings have been made in permanent molds. It is stated, on unquestioned authority, that Germany has used semi-steel for shell-making purposes for the last 15 years.

Low-Phosphorus Iron is Soaring

The possible drawback to the present employment of the French process is the scarcity of low phosphorus pig iron and scrap. No grade of iron has attained such a height in price within the memory of those now engaged in the industry, and the indications are that it will go still higher. One sale of a small lot of low phosphorus pig iron recently was made at $100 a ton and for delivery during the first quarter of next year, $82.50 per ton is asked by some eastern furnaces.

To overcome this disadvantageous position, if possible, foundrymen have sought the use of increasing amounts of scrap in their charges, until an all-scrap process has been developed that is giving satisfactory results. So sensitive is the iron market, however, that these increased purchases of low phosphorus scrap were felt immediately, with the result that prices began to sky-rocket. Within the last 30 days advances of $15 per ton have been made and in the east, where this acid steel process predominates, this scrap now is quoted at $52 per ton. Even at this price its use is more economical than pig iron, but further advances are anticipated which might put this material out of the running and in a class with low phosphorus pig iron.

The Future of the Trade

The future of both the pig iron and the scrap markets are giving foundrymen much concern. That higher prices will prevail is certain, since the production of pig metal is inadequate to meet the present needs. The requirements of steel products for the government are constantly soaring and with the steel production leaving the pig iron output far in the rear, the reason for increased scrap consumption and vaulting prices becomes apparent.

Electric Steel Output Increases 85 Per Cent

STEEL castings reached the peak of their production in the United States in 1916 with a total of 1,371,763 tons, which exceeds by 351,019 tons, the previous high point recorded in 1913, when 1,020,744 tons were made. In 1915 the output of the steel foundries was 866,824 tons and the increase over that year in 1916 was 504,939 tons, or 58 per cent. Basic steel castings almost doubled their total of the previous year, when 333,103 tons were made. In 1915 the output of acid steel was 402,229 tons and is in excess of basic steel, 69,126 tons. However, in 1916 the acid steel process fell below the total for basic with a production of 570,937 tons. The total acid and basic production was 1,176,449 tons, ac compared with the best previous output in 1913 of 910,216 tons. The converter steel process likewise showed a gain with a production of 142,791 tons as compared with 92,476 tons the previous year. Castings made by the crucible steel process, however, showed a big falling off in tonnage, with a total of 9,351 tons as compared with 14,756 tons in 1915 and a high point of 20,550 tons in 1912. This decline in the output of crucible steel castings may be attributed largely to the difficulty experienced in obtaining crucibles and to the high prices prevailing for these pots.

The tremendous increase in the application of the electric steel process is evidenced by the output of electric furnaces in 1916, which showed a production of 42,870 tons against 23,064 tons the previous year. This shows a gain of 19,806 tons, or 85 per cent. In 1909 the first statistics on electric steel castings production were available, when 306 tons were made. In 1913 this had grown to 9207 tons and the greatest advances in this practice were recorded in 1915 and 1916.

Alloy steel castings attained a total of 56,458 tons, of which 2200 tons were made by the basic open-hearth process, 26,134 tons by the acid open-hearth process, 30,833 tons by the basic process, 815 tons by the crucible process and 926 tons by the electric process. The accompanying tables give the production of steel castings since 1902.

The production of steel castings in Canada in 1916 totaled only 31,313 tons against 39,490 tons the previous year. Canada's entire steel production was 1,286,509 tons whereas the total for the United States last lear was 42,773,680 tons. The American Iron and Steel institute also has gathered data on the manufacture of cast iron pipe which totaled 1,214,333 tons in 1916 and 1,096,770 tons the previous year. Gas and water pipe constituted 874,129 tons of last year's total and fittings for this pipe, 60,497 tons. Soil and plumber's pipe totaled 206,494 tons and fittings therefore, 73,213 tons. The total production of fittings last year was 133,710 tons against 118,100 tons in 1915. The total output of cast iron gas and water pipe and fittings and soil and plumber's pipe and fittings in Canada, in 1916, was 43,850 tons, as compared with 53,700 tons the previous year, a decline of 9850 tons.

Production of Steel Castings in the United States

Years	Open hearth—Basic	Open hearth—Acid	Open hearth—Total	Bessemer	Crucible	Electric	Miscellaneous	Total. Gross tons
1902	112,404	255,475	367,879	12,548	4,955	.....	5,553	390,935
1903	134,879	265,469	400,348	18,099	5,409	.....	6,409	430,265
1904	98,919	203,915	302.834	16,051	4,308	.....	7,018	330,211
1905	206,159	320,381	526,540	22,103	5,733	.....	6,391	560,767
1906	313,548	406,343	719,891	32,601	10,343	.....	10,870	773,705
1907	366,476	380,049	746,525	33,273	10.233	.....	13,086	803,117
1908	155,005	156,772	311,777	20,559	8,271	.....	5,613	346,220
1909	306,005	295,035	601,040	33,814	12,683	306	8,399	656,242
1910	433,976	429,375	863,351	58,335	14,632	1,320	3,194	940.832
1911	266,626	304,565	571.191	57,101	14,030	1,878	2,427	646,627
1912	443,998	426,850	870,848	68,750	20,550	4,162	2,311	966,621
1913	460,161	450,055	910,216	80,506	17,571	9,207	3,244	1,020,744
1914	334,144	270.173	604,317	65,882	11,186	8,551	3,310	693,246
1915	333,103	402,229	735,332	92,476	14,756	23,064	1,196	866,824
1916	605,512	570,937	1,176,449	142,791	9,351	42,870	302	1,371,763

How Cores For Motor Car Castings Are Made

A Description of the Methods Employed by the Ferro Machine & Foundry Co.—Core Room Refinements Facilitate Large Production

AN HISTORIAN states: "Iron founding received an impetus in the latter part of the eighteenth century, such as it had never before experienced. The steam engine of Watt, coming into use at this time, developed the iron manufacturers at a wonderful rate, as by its means blast power was increased and all rude contrivances driven by horses and oxen were gradually abandoned in favor of the blowing engines driven by steam." Of equal, if not greater, importance in the development of the founder's art is the invention of the gas engine. The invention of these two types of engines with more than a century intervening, marks the beginnings of two great epochs in foundry practice. The advent of the modern gas engine has developed a special branch of foundry work which is closely akin to the machine shop in the accuracy of its work. The molder, coremaker and patternmaker have all been called upon to acquire increased skill.

Unusual Skill is Required

Intricacy of design and the thinness of section demanding innumerable cores present difficulties to the maker of automobile castings which not only demand skilled workmanship in all departments, but also require unusual ingenuity in laying-out the work and in the development of special molding machines. One core, that of the cylinder head for example, is made of more than 20 separate parts so designed that the thickness of the metal is only ⅛ or 7/32 inch. Such work necessitates machines which will make the cores with extreme accuracy and assembling devices and jigs, assuring the utmost precision in alignment and workmanship.

Developments in Patternmaking

Patternmaking, too, has undergone radical improvements. The refinement of this class of work does not permit the use of the old wood core boxes and patterns. The metal-working department of the patternmaking shop is an essential feature of a modern plant. Core boxes are made of metal and machined to the hundredth part of an inch. The patterns are all machined from special castings made from the original master patterns.

High-grade workmanship and means to secure expediency in production extend beyond the pattern shop and the core room to the foundry where the metal and the sand are prepared with extreme care using every precaution known to scientists to secure the best of results. The molds are made on automatic machines which give maximum production without sacrifice of accuracy. The sand is carefully selected and prepared to insure smooth castings free from blowholes and similar defects. The metal must come within the close restrictions of a rigid analysis and must be poured at a temperature which will preclude the possibility of cold-shuts and other ills that such castings are heir to.

One of the many foundries which have been successfully handling automobile engine work is that of the Ferro Machine & Foundry Co., Cleveland. The complete equipment of this plant and the large scale of production make it of unusual interest. One of the outstanding characteristics of the foundry work handled by the Ferro company is the great diversity of castings. The many different types include parts ranging in size from those for the smallest four-cylinder automobile, to the more complicated sizes, eights and twelves to the enormous heavy-duty engines designed for submarine chasers.

Practice in Pattern Shop

Forty patternmakers working in a large, light shop make the various patterns, core boxes and driers for the core room and foundry. A section of the shop, which is 40 x 140 feet, is shown in Fig. 1. Drawings received from the engineering department are laid out in the pattern shop for the master patterns and the cores. The master patterns are made from selected white pine of which

FIG. 1—THE MASTER PATTERNS ARE MADE IN A LIGHT, WELL-EQUIPPED SHOP

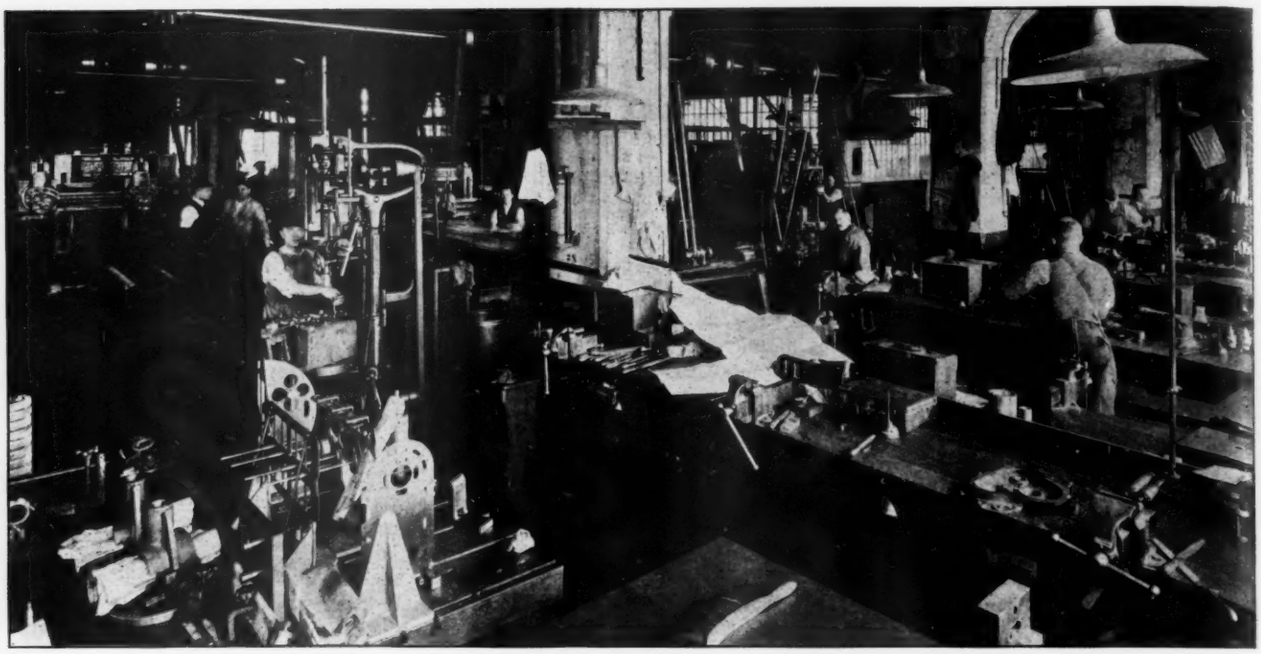


FIG. 2—TOOL ROOM WHERE THE METAL PATTERNS ARE MACHINED AND ASSEMBLED

a stock of standard sizes of 3000 to 4000 board feet is kept in storage. This plan allows the wood to thoroughly season and eliminates the danger of shortage of lumber. Special work, where warping is liable, is made of mahogany. In general, all patterns are built in sections to facilitate machining and assembling. After brass or aluminum castings for the metal pattern have been made, they are sent to a checker who lays out the machine work. All the patterns are machined in the company's tool room which is adjacent to the pattern shop. A corner of this room showing a few of the machine tools and part of the assembling benches is illustrated in Fig. 2. When the parts have been machined and cleaned they are assembled and sent again to the checker who approves them or returns them to the tool room for necessary changes. A striking illustration of the value of cooperation is afforded by a plan in effect in this shop. While the pattern is being made, the head patternmaker keeps in touch with the foremen of the core shop and foundry who go over the details and pass on such matters as gating, heading and proper design and arrangement of cores. No pattern is allowed to leave the shop until it has the approval of the heads of these departments. Driers are made for all complicated cores. The patterns for these usually are made of plaster of Paris. White metal or cast iron is used for the drier castings.

Both the metal pattern shop and the tool room are well equipped. Two band saws, one for metal and one for wood, a pony planer, jointer and a rip saw made by the Oliver Machinery Co., Grand Rapids, Mich., constitute the major portion of the equipment of the pattern shop. In addition to these tools, there are speed lathes, drill presses and a Gardner sander which carries two 29-inch wheels providing both sand-paper and carborundum surfaces. All of the

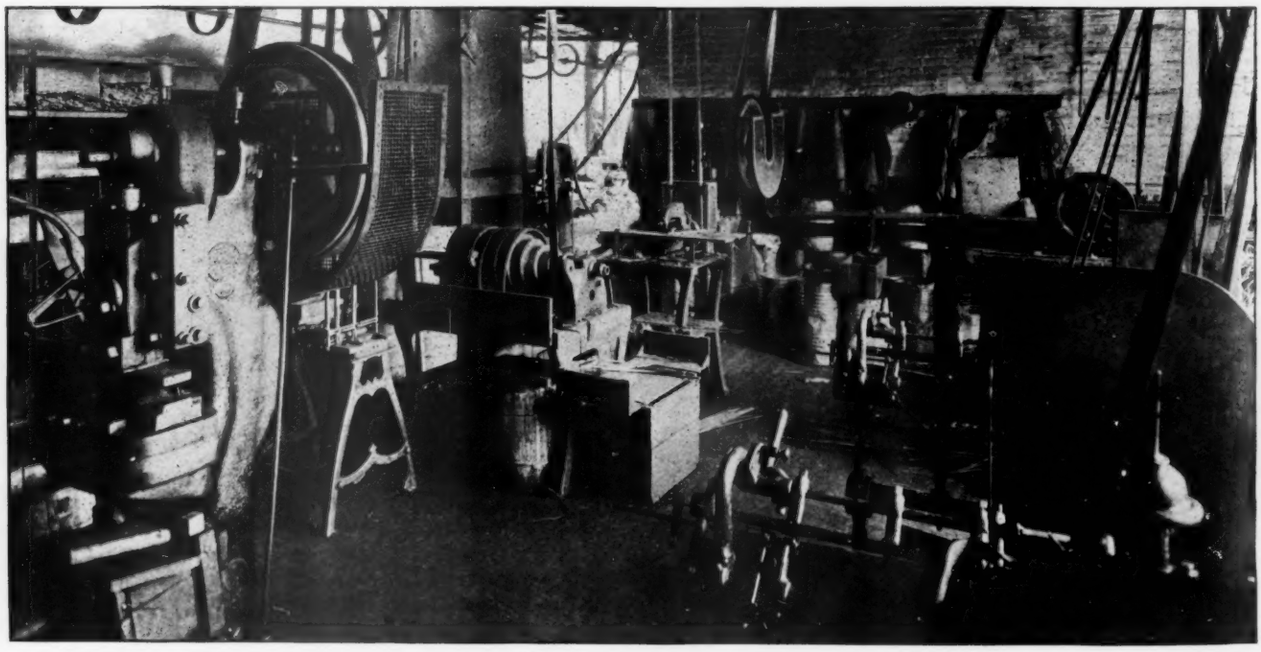


FIG. 3—COREMAKERS IN THE FERRO PLANT USE TWO TONS OF CORE WIRE A DAY—MACHINES IN THIS DEPARTMENT CUT AND BEND THE WIRE TO DESIRED SHAPE

wood-working machinery is equipped with suction pipes to carry away the dust. The tool room, which is 100 feet wide and 200 feet long, and employing 65 men, is equipped with planers capable of handling work 4 x 12 feet, boring mills which will carry work 4 feet in diameter and about 50 other machine tools. The tool crib which is located in the tool room, serves both departments. Numerous tungsten lamps in large reflectors give adequate illumination for night work.

Men working on patterns in either the wood shop or the tool room keep accurate account of the time they spend on each piece. A time card is supplied for each job on which is recorded the time at the start and finish of every period the men devote to it.

Every effort is made to facilitate the work in these shops. A night crew of six men is employed in the pattern shop to repair any equipment which may have failed during the day. Broken patterns and core boxes constitute a large portion of this night work. Large steel racks and numerous shelves provide adequate storage space for the patterns and core boxes. Each pattern is carefully indexed so that it may be located without delay and master patterns are retained until there is no liability for additional patterns for larger orders demanding an increased scale of production.

Specialty Work Brings Core Room Refinements

The greatest change wrought by the refinements introduced with the casting of cylinders for self-propelled vehicles is to be noticed in the core room. In foundries of two or three decades ago, one or two coremakers could turn out sufficient cores to keep several molders busy. The specialty foundries devoted to the automobile industry today frequently employ as many coremakers as molders. The complete core for a modern gas engine, when assembled in the mold, may be composed of as many as 50 separate parts. That the founder appreciates the accuracy and dexterity of a good coremaker is indicated somewhat by the wages being paid for this class of work. It is a poor workman who cannot earn at least $5 a day making cores for the modern, light weight, efficient gas engine. Special molding machines designed to produce cores with great accuracy in a minimum of time, aid the coremaker to make the most of his piecework scale of wages. The coremaker has at his disposal helpers who place his cores in the ovens and keep his stock of sand from running short. Outside of the labor necessary to make his cores, the only labor demanded of the coremaker is to place the finished core on a convenient rack in front of the drying oven where the cores are baked.

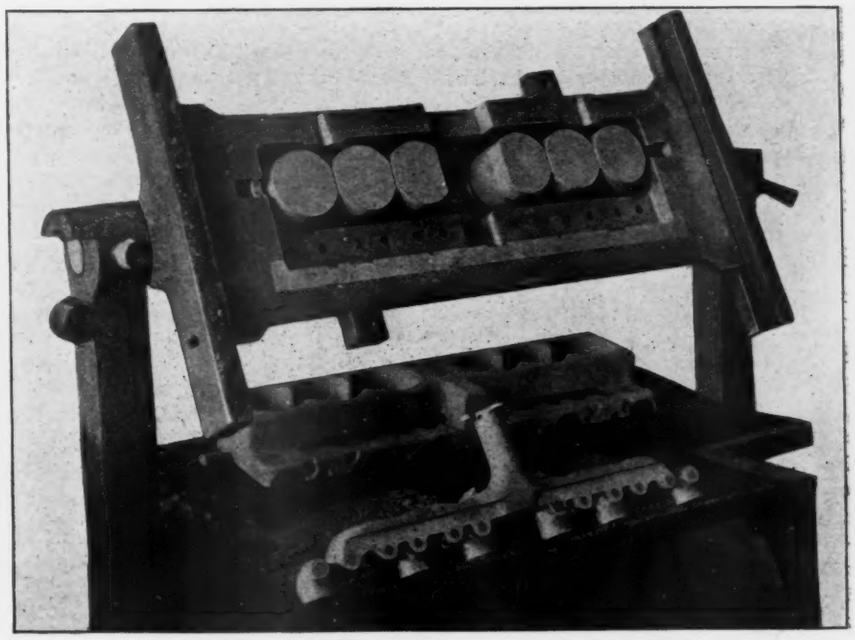


FIG. 4—COREMAKING MACHINE WHICH HAS ROLL-OVER AND JAR-RAM FEATURES

The core rooms of the Ferro Machine & Foundry Co. employ 150 coremakers and 40 laborers who use two car loads of sand a day. The sand is dumped from the cars on the company's siding into a special hopper which regulates the flow of sand to a traveling belt. This belt carries the sand about 1200 feet to the sand mixing machine which has a capacity of 600 quarts per batch. The mixing machine, which was made by the Standard Sand & Machine Co., Cleveland, is so arranged that one charge of sand may be prepared while another is being mixed. Eight batches may be prepared per hour. Three different grades of sand are used in the core rooms of the Ferro plant. The variation in closeness of the three grades is utilized to provide for different degrees of gasing. Michigan City and bank sands form the basis for the mixtures. Oil, made by the Werner S. Smith Co., Cleveland, is used in proportion of 1 to 65 as a binder. From the time the sand enters the railroad hopper until it reaches the coremaker, it is not touched by hand. The mixing pit is so arranged that the sand may pass directly to the mixing machine where the oil is added.

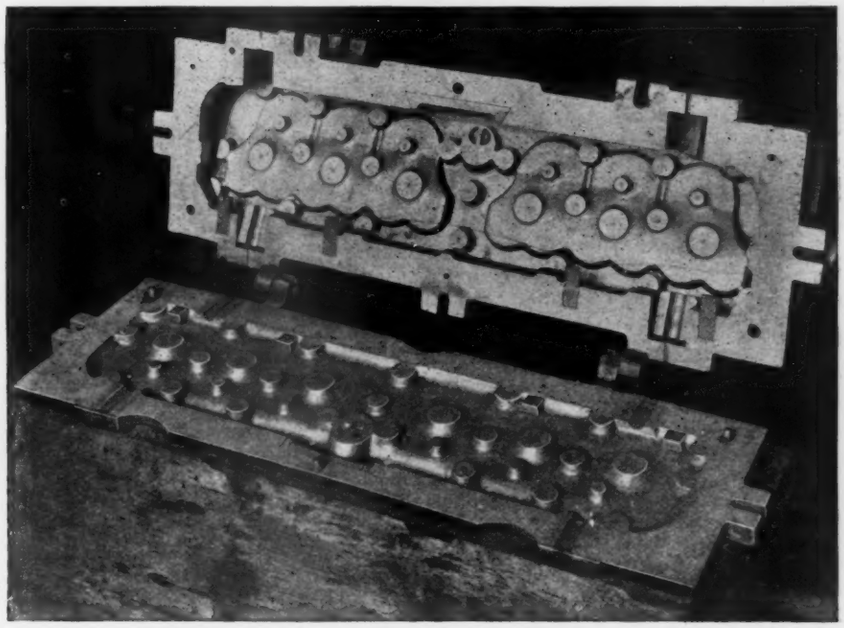


FIG. 5—IMPROVED CORE BOX FOR MAKING CYLINDER HEAD CORES—ITS CONSTRUCTION ELIMINATES THE LOOSE PLATES OF THE CUSTOMARY BOX

Passing from the machine, the sand is carried to the core room on the second floor by a bucket conveyor which dumps it into one of three storage bins depending upon the mixture. The discharge of the sand into these bins is regulated by a control handle near the mixing machine in the basement. Sand for the large core department in the basement is drawn through chutes from the bins on the second floor. Parting compound is used sparingly in the core boxes. They are blown out with compressed air and cleaned occasionally with kerosene. On cores having delicate structure lycopodium is used.

One of the unique machines in use in the core room, which was designed by J. T. Stoney, superintendent of the foundry, is shown in Fig. 4. It is actuated by compressed air and combines both air drawing and air ramming features. The illustration shows the core box rolled over in a position to be photographed after the core has been drawn. Nine or 10 inches straight vertical draw is possible with this equipment, and, where necessary, a draw of 13 inches may be obtained by tipping the core box as it is drawn and sliding the core away from the bench. The machine, shown in Fig. 4, is used to make the water jacket for a six-cylinder engine.

An interesting feature of the method of molding water jackets and other cores having circular sections is that they are split flatwise wherever possible, to eliminate the necessity of sweeping the cylindrical surfaces in the core box. This scheme makes necessary a slight departure from regular practice, in some instances, in locating the core prints, but this is more than compensated for in the time saved and by the elimination of machined, cylindrical driers to fill in the barrel sections of the jacket. This method assures great accuracy in the thickness of the walls of the water jacket.

One of the most complicated cores with which the coremaker has had to cope is that for the cylinder head. The thin metal section and the intricacy of design of the cylinder head have served to make the production of the core for this part of the engine, a task requiring infinite care. The type of core box illustrated in Fig. 5 is in general use in the core rooms of the Ferro company. It eliminates some of the difficulties experienced with previous methods which included the use of loose plates. In employing the customary style box with the separate plate which is put into place after the lower part of the box has been rammed with sand, it was found that trouble was experienced in removing the sand from between the bosses which provide the openings in the cylinder head for intake and exhaust valves, etc., and in properly locating the loose pieces. This was accomplished by probing between the surfaces of the two bosses after the plate had been placed in the sand. The improved box, however, is split through the center and hinged, as clearly indicated in the illustration. The upper part which replaces the loose pieces formerly driven into the sand, is so arranged that it may be withdrawn from the upper hinged half. In making the core for the cylinder head with this box, the two halves are separated at the open hinge and rammed individually. After this operation, the two halves are placed together and locked by thumb screws at each end of the box. These thumb screws serve both to hold the compression plate in place while the upper half is being rammed and to lock the box when the two parts are assembled. The compression plate is then withdrawn from the box leaving the two hinged frames still locked. Driers are then dropped into position and a steel plate put on the box. It is then rolled-over and the frames are withdrawn from the core. The time of making cylinder-head cores with this box is said to be about one-third that required for molding with the loose plate box. Reinforced steel core plates, made by the Wadsworth Core Machine & Equipment Co., Akron, O., are used in both core rooms.

A gage of the number of cores made in one day is the amount of core wire used. The wire room, a portion of which is shown in Fig. 3, handles approximately 2 tons of new and old wire a day. About 80 per cent of the core wire is reclaimed. The equipment of this department includes bending, pressing and cutting machines. Work that cannot be handled by machines is bent to form in bench jigs. The various shapes and sizes of core wires are stored in steel racks where they are readily accessible for the coremakers. All the chaplets are cut and bent in this department. Every means is taken to prepare the wire in such form that it will save the coremaker the maximum amount of time.

All cores, with the exception of crankcase and similar large cores, including water jacket, port and pipe cores are made on the second floor where they are placed by the coremakers on racks

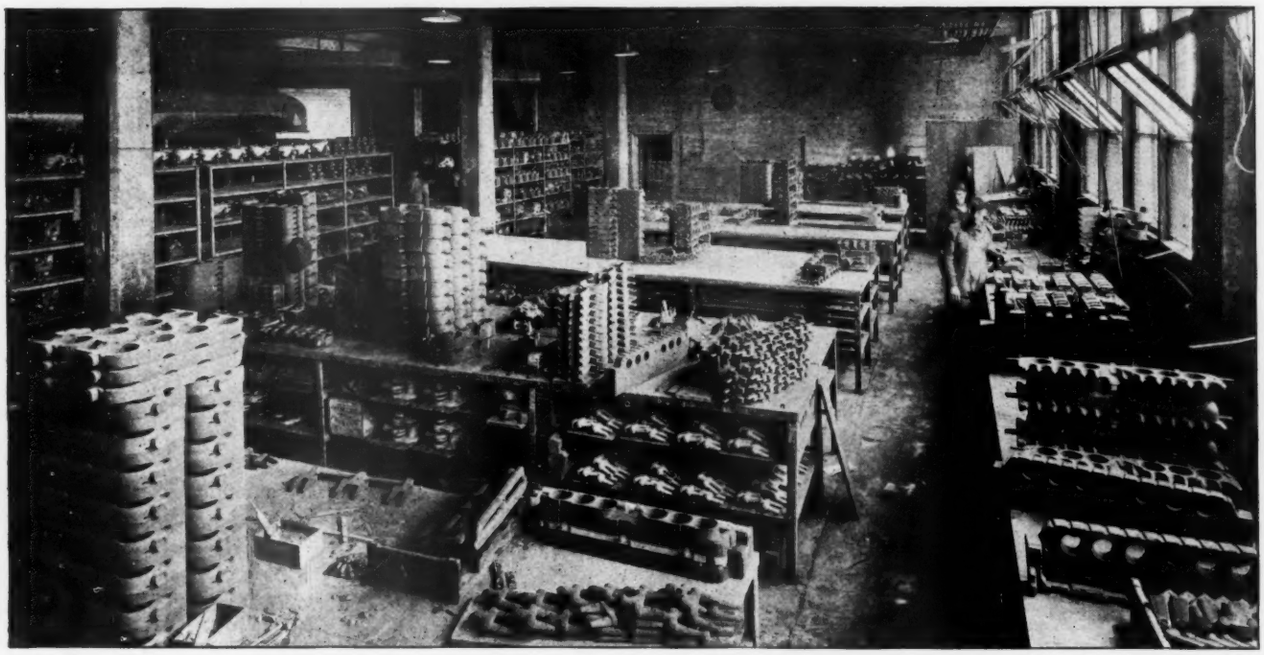


FIG. 6—ONE OF THE LARGE CORE-ASSEMBLING ROOMS WHERE THE CORES ARE FILED TO EXACT SHAPE IN JIGS

near the ovens. The venting of these cores is accomplished entirely without the use of coke. Cores of small cross-section depend upon the porosity of the sand. Larger cores are vented by inserting ½-inch brass tubes which remove a portion of the sand when they are withdrawn, thus providing egress for the gases. This operation is similar to sprue cutting on a bench molding job. The cores are baked in three coke-fired ovens at a temperature of 400 degrees Fahr. The temperatures are recorded by Bristol pyrometers. The duration of baking varies, of course, with the size of the core. Core driers are universally used to prevent distortion during baking, thus holding the cores to correct form.

After baking, the cores are placed on trucks and carried to the assembling department on the first floor. Stock racks are arranged there for storing cores awaiting to be assembled. A portion of this department, showing some of the storage racks and drying ovens is illustrated in Fig. 6. Before being assembled and pasted, all the cores are placed in jigs and filed to exact size. After drying the paste, which is a mixture of dextrine and flour, the cores are again stored in readiness for the demands of the foundry. The ovens in this room are located directly below those in the coremaking department on the second floor and are heated by the same fires. One of the most unique features of the core assembly department is the method of leading cores to hold the different sections in the precise position desired. This method is not only used because of its inherent accuracy, but because it serves to eliminate the use of chaplets in many places where they have been the cause of difficulty. Fig. 7 shows the jig with a core ready to lead and a completely leaded and assembled core. A close study of this illustration will reveal the manner in which the leading is accomplished. A loop of wire is embedded in the contact surface of one core; this projects into a hole in the corresponding contact surface of the second core. By pouring molten lead into the hole and allowing it to flow under the loop of wire and harden, the two cores become fastened firmly together. Because the cores are fastened securely together, they resist the pressure of the molten metal and the danger of leaks in the casting such as occur when chaplets do not fuse is entirely eliminated.

The larger cores are made in the basement of the foundry building. To a large extent, the same general plan is followed there as in the small core department, automatic machines being employed wherever possible. The system of handling the heavy cores, however, is especially interesting. As the cores are made they are placed on steel racks similar to the one shown in Fig. 8. On

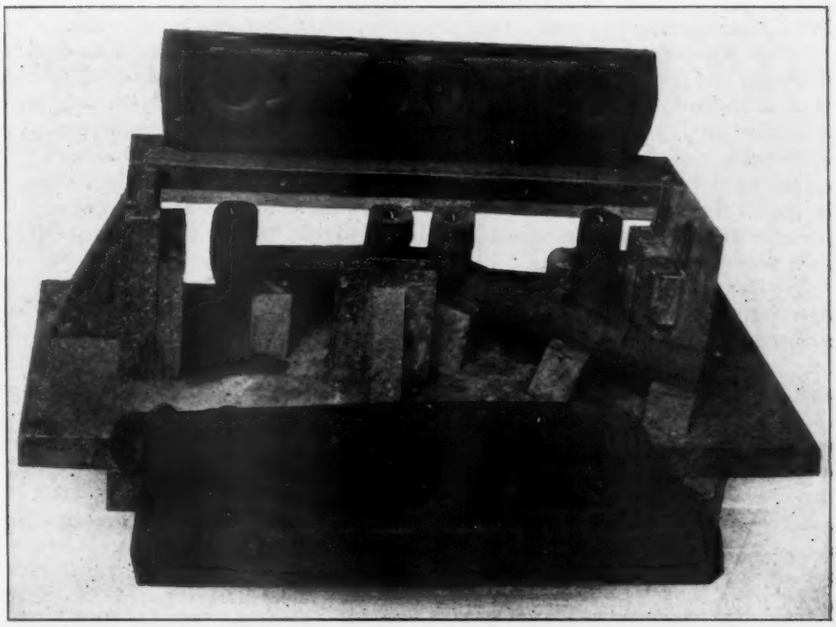


FIG. 7—UNIQUE METHOD OF LEADING CORES SECURES THE PARTS FIRMLY TOGETHER AND ELIMINATES THE USE OF CHAPLETS IN MANY PLACES

the ceiling above each of the six divisions of this department are arranged six crane arms pivoted in the center of a circular track. The racks loaded with cores are picked up by one of these cranes and swung around to a crane track which runs along the ceiling in front of the battery of six gas-fired core ovens. A junction of a circular track with the straight track may be seen at the right of the illustration. The racks are dropped to the floor and are picked up by an electric traveling carriage operating on the track in front of the ovens. When the traveling crane or carriage has carried the rack to the oven, a detachable lifting mechanism is transferred from an auxiliary track on the crane carriage to tracks running into the oven. After lowering the rack to its place in the oven, the lifting mechanism is returned to the crane carriage ready for further duty. The track running in front of the ovens makes a complete circuit so that it may be loaded from one side and unloaded on the other. The large cores are allowed to remain in the oven for six or seven hours. Large vent pipes extending to the roof of the building serve to exhaust the

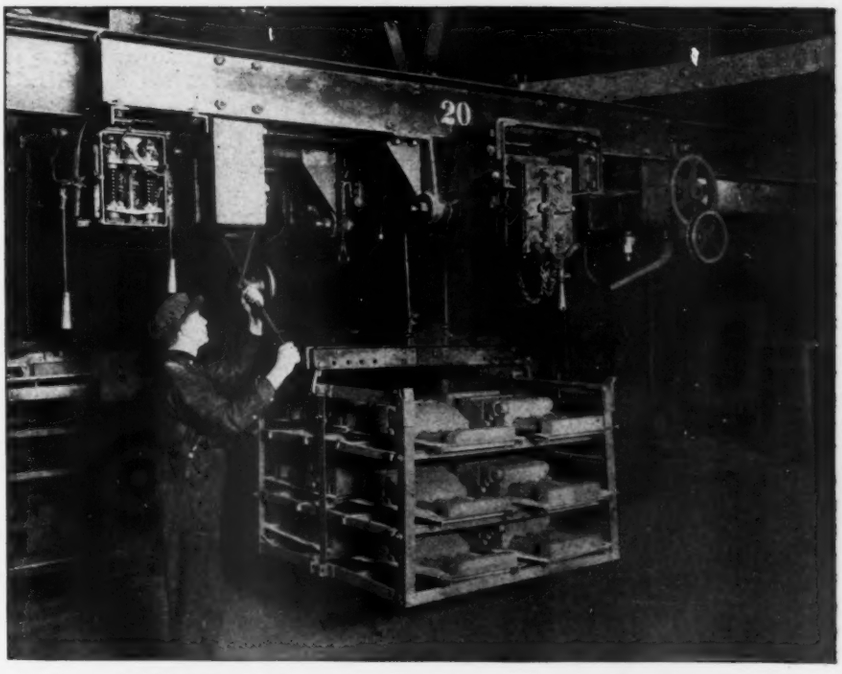


FIG. 8—HOW THE LARGE CORES ARE CARRIED TO THE OVENS—CRANE ARRANGEMENT SAVES LARGE AMOUNT OF LABOR

burnt gases and existing moisture.

Where a smooth surface is desired on the cores, they are sprayed while green with a mixture of talc and water. No binder is used, the binder in the core sand being sufficient. Small cores are dipped and air-dried, drying in about 1½ hours. This mixture is also used as a paste to daub the joints of cores which have been cemented together.

The plans on which the core rooms are operated assure a large supply of cores available at all times for use in the foundry and preclude any possibility of shortage. In fact, the core department endeavors to work three days in advance of the foundry. These days may be divided into three periods representing cores being made, cores being assembled and cores in storage. The great variety and volume of work carried on in the foundry of the Ferro Machine & Foundry Co. presents a number of unusual problems which are of equal interest to those of the pattern shop and core rooms. A description of the special equipment and the methods employed in this foundry will be published in an early issue of THE FOUNDRY.

Book Reviews

The Founder's Manual: by David W. Payne, editor of *Steam;* limp leather; 680 pages, 5 x 7 inches; 245 illustrations. Published by the D. Van Nostrand Co., New York, and furnished by THE FOUNDRY for $4 net.

Information of interest to foundrymen can be found in a large number of publications devoted to casting problems. Those in search of data, however, not always have been able to secure the desired facts without going to an undue amount of trouble in determining the proper source of information. *The Founder's Manual,* by David W. Payne, overcomes this difficulty by combining in one volume a vast amount of material for the solution of problems which are continually presented in the foundry. Many articles and tables published in THE FOUNDRY are reproduced in full.

The first three chapters are devoted to elementary mathematics, tables of weights and measures, and natural sines and tangents. In Chapter IV, the weights, dimensions, strengths, etc., of various materials are tabulated. The following chapter is devoted to a brief statement of the principles of mechanics. Chapters IX to XIII contain some unusually valuable information regarding the chemical constituents of cast iron, the theory of mixing irons, and data regarding steel scrap in mixtures of cast iron, the use of test bars in determining the physical properties of cast iron, and the value of chemical analyses. Chapter XIV is devoted to standard specifications for cast iron wheels, locomotive cylinders, and cast iron pipe. Mechanical analysis is the subject of Chapter XV, which includes a description of the shrinkage chart and an explanation of Keep's shrink table. Chapter XVI is devoted to malleable cast iron and traces the development of the malleable industry from the time of Reaumur's discovery. The next chapter is devoted to the manufacture of steel castings. This is followed by a wealth of information on foundry fuels, a description of various types of cupolas, molding sand, including mention of bonding power, permeability and porosity, refractoriness, durability and texture; the core room and its equipment; molding room apparatus; molding machines, including jigs, flasks; and a discussion on molding.

Other chapters are devoted to discussions on continuous melting, the determination of the weights of castings, including methods of finding the weights of patterns, pattern lumber, and formulas for obtaining the required weight on copes; gas, water, lighting, heating and ventilating. Chapter XXVII covers the subject of foundry cost accounting in a thorough manner. Foundry requisitions, pattern cards, heat book, and various other records are reproduced. A pig iron directory is one of the features of *The Founder's Manual.* Coke, anthracite and charcoal irons are classified separately, the trade name of the iron is given and in addition the number of furnaces, the locations of the stacks, the name of the operators, type of blasts used and the kinds of ores employed are included.

Organization in Accident Prevention; by Sidney Whitmore Ashe; cloth; 130 pages, 6 x 9 inches; published by the McGraw-Hill Book Co. and furnished by THE FOUNDRY, for $1.50 net.

Accident prevention is a problem which is occupying a constantly growing place in modern industrial life. Interest in the work prevails for two reasons—a humanitarian effort to prevent suffering, and the natural desire of the business man to keep his plant running at as near 100 per cent efficiency as possible. He cannot accomplish this if his working force is constantly shorthanded because of preventable accidents.

To make accident prevention truly effective the employer must study organization and must see to it that his foremen and their assistants are prepared to work with him. In other words, he must have co-operation. How this can be brought about most effectively is shown by the author of *Organization in Accident Prevention.* "Fellowship, system, education and discipline are the four necessary elements in safety and health work." The co-operation of the employe, engendered by a feeling of fellowship, is the greatest help that the employer can have in safety work. Also, a definite system of work with definite men in charge is desirable in order to get satisfactory results. This system when perfected, will contain a complete plan for the education of the employe in the methods of preventing accidents, and will also provide disciplinary measures which may be necessary in some cases to force the employe to take the prescribed precautions.

Chapter II discusses specific accidents which may be reduced by educational means. The author describes the best methods of avoiding these accidents and the most effective methods of treating them if they do occur. Another chapter is devoted to the consideration of the subject of medical and physical examination of employes with special reference to tuberculosis and hernia. The necessity of emergency treatment in the plant itself is discussed and the various emergency methods described. The emergency hospital at a plant plays an important role at times.

The vital necessity for accident prevention work is strikingly shown by the statistics given in the chapter entitled "Records, Analysis, Ratio Curves". Many interesting illustrations are shown.

Calcium and Its Uses

Calcium in appearance somewhat resembles sodium, but unlike the latter it is not soft, but hard and tough and difficult to cut with a hacksaw or a hammer and chisel. Calcium readily alloys with copper and may be added to the molten copper like any other metal, provided the calcium is first warmed and is not too suddenly pushed under the surface of the copper. The union of the calcium with the copper is attended by the liberation of great heat, much more than in the case of the addition of aluminum to copper. The addition of 10 per cent calcium to copper increases the temperature of the latter to approximately 1400 degrees Cent. Copper, with 5 per cent calcium, is hard and brittle, and can be broken with a hammer; with 10 per cent calcium the alloy still retains its hardness and brittleness, but becomes filled with gas cavities. With 50 per cent calcium, the alloy becomes silvery with a yellowish cast, and consists of long crystals easily detached as slivers. The alloy is soft and exceedingly active chemically. It will combine with chlorine in common salt and liberates the sodium; it combines with the oxygen in alumina and liberates aluminum, and with sulphur it combines with explosive violence. Calcium copper smells strongly of acetylene gas. It will not deoxidize copper, to make solid copper castings, with any degree of uniformity, but if a sound casting is obtained the electrical conductivity is very good.

Increasing the Output of the Plating Room

How the Efficiency of Workmen and Equipment Can Be Increased—Losses of Electrical Energy Retard Production

By E P Later

EVERY plater occasionally is confronted with the necessity of handling a largely increased volume of work, resulting either from the normal growth of the firm or from improved business conditions, and then the question of how to increase the capacity of his department with the least expenditure of money presents itself for solution. Two ways of increasing the output immediately are considered, namely, by adding new equipment, or by raising the efficiency of the workmen and equipment available. The latter course, naturally, is always to be preferred, inasmuch as new tanks and machinery are costly and, in addition to this, the increased floor space used, larger amount of power required, and so on, are expensive items which eat deeply into profits.

The prices of almost everything have advanced to such heights recently, and the delay in obtaining supplies has been so great, that additions to the plant can be made only with much difficulty and expense. This is particularly true of generators and electrical apparatus in general, the scarcity and high price of copper and brass, as well as other conditions serving to make such appliances hard to get at any price.

Investigate Present Equipment

For various reasons, therefore, every effort should be made, before adding new equipment to take care care of an increased amount of work, to see that the present outfit is really working at its full capacity. Very often surprising economies and improvements can be made by a thorough overhauling of everything, with the view of correcting whatever unfavorable conditions come to light and making such alterations as experience or inspiration may suggest.

To be of the greatest value such an investigation should be as complete as possible and a few suggestions, serving merely to indicate some of the more important points to be noted, may not be out of place. For instance, one source of wasted motion and effort on the part of the workmen is faulty arrangement of the various cleaning and plating tanks and other equipment, and a short study of this feature often will show how an improvement can be made easily and cheaply.

The formulas for the various plating solutions also should be examined to see if they are in accordance with the latest information and best practice; with some of the newer formulas it is possible to use much higher current densities than formerly, and inasmuch as this means turning the work out in a correspondingly shorter time, thereby increasing the output of the plant, it is apparent that an investigation of this kind may bring large returns.

Losses Due to Dilution

Maintaining the solutions of the correct composition also is a factor too important to be overlooked. The composition is certain to vary more or less with use, due to loss of solution, dilution, and impoverishing from imperfect corrosion of the anodes, and unless this is corrected, losses of one kind and another will surely be incurred.

Lack of proper care and attention to the generator, poorly made or corroded connections, dirty contacts in the rheostats and too infrequent cleaning of anode and cathode rods may, and often do cause large losses of electrical energy, thereby lowering the general efficiency of the plant; instead of doing useful work in the plating tanks or electric cleaners the current is wasted in overcoming all of this unnecessary resistance. Again, faulty insulation sometimes alows current to leak from anode to cathode without passing through the plating tanks; or the mains and leads may be too small to carry the current used, in which case they will become hot and thus further dissipate electricity in the form of heat.

After conditions of this kind have been removed, or have been shown not to exist, it may be found that the capacity of the plating equipment is still somewhat below requirements and in this case the use of a storage battery may be a convenient way out of the difficulty; such a procedure has several points in its favor.

First, it may permit of the installation of an additional tank or so without making it necessary to put in a larger generator at the same time. This may be more clearly understood when it is remembered that the load in the average plating room is subject to rather large variations. Often it is not possible, for one reason or another, to operate all of the tanks at once, or the parts which are being plated may be of such shape that a comparatively low current is used. On the other hand, the generator must be large enough to operate all of the tanks and probably an electric cleaner, which alone will usually take several hundred amperes, at one time. The result in either case is unsatisfactory in some ways. A dynamo running below its normal capacity does not operate at its maximum efficiency and if it is too heavily overloaded it will soon heat badly and may burn out. In short, a storage battery often can be utilized to advantage to keep a generator running at somewhere near its full rating when the plating load is light, by storing-up the excess and supplying current at other times to help out the dynamo during overloads. In this way the actual capacity of the power plant not only can be increased considerably, but a much wider range of voltage can be obtained, when desired, than otherwise would be the case. This point will be taken up later.

Advantages of Storage Battery

One of the greatest advantages, at least in certain instances, and one which alone would perhaps be sufficient to justify the use of such a system, is the opportunity thus afforded to work the solutions at times when they are ordinarily standing idle. At noon, for example, the power usually is shut-off for an hour, and counting the time lost in taking the work out and putting it back, considerably more than one hour easily may be lost. In a working day of only eight or nine hours this is a rather serious matter. If a storage battery is available the output of the tanks can be increased by at least one full load a day, for during the noon hour the battery can be switched on, using a sufficiently lower current density than usual if necessary to compensate for the increased length of time that the parts are plated, and deposition may be continued without interruption.

In the same way certain classes of work requiring a heavy deposit can

be plated over night without difficulty, always bearing in mind, of course, the necessity of cutting down the current to the proper strength in order to obtain a deposit of the desired weight.

A little reflection will show that the use of an auxiliary storage battery presents several advantages and possibilities, but before going into some of these in more detail, it may be helpful to review a few facts concerning the construction and operation of this piece of apparatus.

The type of cell most widely used for work of this kind consists of specially-prepared lead plates immersed in a dilute solution of sulphuric acid, contained in jars made of glass or other suitable material. One of these plates is coated with a compound known as lead peroxide and forms the positive plate or pole; the other is covered with sponge lead—a certain form of metallic lead—and constitutes the negative plate. They can be distinguished, when the cell is in good condition, by the fact that the positive plate is of a distinct brown color, while the negative plate is gray; incidentally, the positive plate is quite hard, while the negative is much softer. These plates usually are thin and it is thus possible to place several of each polarity in the same container, connecting all of the positive plates together at one terminal and all of the negative plates at the other terminal, the two sets of plates being so placed within the container that each positive plate has a negative plate next to and facing it on both sides. Inasmuch as adjoining plates are all of opposite polarity it is necessary to keep them completely separated and well-insulated from each other, or short-circuiting of the cell will occur. Free circulation of the electrolyte must not be interfered with, however, so glass rods, or perforated rubber or composition strips are employed to keep the plates separated.

How Electricity is Generated

When a current of electricity is passed through an arrangement of this kind, certain chemical changes are brought about by the action of the current, the latter thus expending its energy in this way and putting the battery into the condition known as charged. When the battery is disconnected from the charging current it will be found that it is capable of giving out a current of its own, by reason of the fact that certain other chemical reactions the opposite of those which took place when the battery was being charged, now occur, in consequence of which electrical energy is set free and may be utilized. More specifically, the change occasioned by discharging, giving out electrical energy, is the gradual formation of lead sulphate on both plates. The positive plate at the end of the discharge is coated with a mixture of lead peroxide and lead sulphate, while the negative plate is covered with lead and lead sulphate. The passage of current through the discharged cell then causes the disappearance of the lead sulphate, with the formation of lead peroxide on one plate and lead sponge on the other; so this alternate charging and discharging may be kept up for a long time if certain precautions are carefully observed.

The lead sulphate which is formed during the discharge of the cell is a white substance having a high resistance and volume greater than that of either the lead or the lead peroxide from which it is formed. It is obviously necessary, therefore, to see that only a limited amount of it is produced, otherwise the plates will be damaged through the expansion and cracking off of the coating material. Partly for this reason a cell never should be completely discharged, but be re-charged or taken out of the circuit when the voltage drops to a certain point.

How the Cell is Damaged

Charging or discharging at too rapid a rate are also capable of doing a good deal of damage to a cell. Lead peroxide occupies a larger volume than the lead from which it is formed; so the volume of the active or coating material on the positive plate undergoes considerable change. It increases when the cell is being charged and decreases when the cell is discharged; therefore, if this expansion or contraction takes place too rapidly, from excessively high rates of charge or discharge, cracking and peeling of the coating will take place. In the same way, the tendency toward buckling or twisting of the plate, which may become a very serious matter, also is increased by carelessness in this respect.

Another source of trouble is the introduction of other metals into the electrolyte, the dilute sulphuric acid in which the plates are immersed. Unless proper precautions are taken this is particularly liable to happen around a plating room, from the splashing of plating solutions onto the cells, and results in very rapid deterioration. Sulphuric acid sometimes contains certain impurities which are detrimental, and it is essential, when it becomes necessary to replenish the electrolyte, that only distilled water and the purest acid are employed for plating room purposes. Finally, a storage battery should not be allowed to stand for too long a time after discharging, otherwise the formation of an excessive amount of lead sulphate on the plates takes place and the battery is said to be sulphated, a condition which is shown by the presence of white patches on the surfaces of the plates. It may be serious enough to ruin the cells for further use and make it necessary to replace the damaged plates. In cases where the sulphation is less severe, however, it may be remedied by overcharging the cells for some time. In order to prevent trouble of this sort, a battery should not be allowed to stand discharged for more than 24 hours.

The voltage of a charged cell may be as high as 2.4, but after it has been working a short time this drops to about two volts and remains fairly constant at this value for some time. Somewhere near the point where the cell is considered to be discharged the voltage begins to drop rapidly and when it falls to 1.8 to 1.7 volts, the cell must be re-charged before further use.

The capacity of the cell, or the amount of current which can be obtained from it, depends largely on the construction and is ordinarily expressed in ampere-hours; one ampere-hour represents a current of one ampere flowing for one hour, therefore the capacity of a cell or battery on discharge would be found or expressed by multiplying the number of amperes flowing by the time in hours. However, the capacity is not entirely a definite and fixed quantity, but varies with the rate of discharge and the temperature of the cell, decreasing with the former and increasing with the latter, at least up to a certain point. In order to have a definite basis for the comparison of cells, 70 degrees Fahr. has been settled upon as the standard temperature and the rate of discharge fixed at eight hours; that is, the eight-hour rate is the flow of current which a cell can maintain continuously for eight hours without the voltage dropping below the minimum allowable. According to this, a battery which can deliver 9 amperes continuously for eight hours would be rated as a 72 ampere-hour battery.

Limit of Discharge Rate

Of course, it is possible to employ such high rates of current flow that the battery would be discharged in a very short time, although the danger of such a procedure has been shown previously, or the current flowing may be made low enough for the battery to keep it up for a very long period. As a general proposi-

tion, it usually is not advisable to let the discharge rate exceed four or five times the normal eight-hour rate, although in certain cases, where a short period of heavy discharge is followed at once by charging, this may be done without harm.

The charging rate also varies; too low a rate is injurious, therefore, the charging current should not, as a rule, be less than about one-fourth that of the normal eight-hour rate, while it will be found that if it is greater than the two-hour rate there will be excessive gasing and the cell will become hot.

The Charging Rate

The capacity and number of cells to be employed will depend on the amount of current which will be required to relieve an overloaded generator at certain periods, or to keep some of the plating tanks going at times when the dynamo is not running, and ordinarily will be calculated on this basis. Suppliers of storage batteries always are glad to co-operate with customers to give whatever help or information may be needed and trouble may be saved by taking advantage of this opportunity to secure the benefits of their greater knowledge and experience.

In connecting-up the battery, the installer likewise will have to be guided by conditions. One convenient and well-known system is to have the battery running in what is known as parallel with the dynamo. In this way it will be charged when the latter is not working at its full capacity and then when heavier demands are imposed, the battery will begin to discharge and thus take care of the excess load. The exact manner of connecting the cells, at least partly, will depend on the voltage of the dynamo, for when a storage cell is being charged the voltage may reach 2.4 toward the end, which means that the charging current must be a little higher than this; consequently, a 6-volt current will charge two cells connected in series, while three cells in series will require a current of about 8 volts. In discharging, however, each cell may be considered to give 2 volts or less; when near the end of the run the voltage drops below this; therefore, three cells will be required to produce 6 volts.

For charging, it obviously is necessary to connect the cells in series in groups of two or three, depending on the voltage of the charging current, with the various groups in parallel, while on discharge it will probably be desirable to add one or two cells in series to each group, thus reducing the number of groups. For example, a battery of 12 cells could be charged in four groups of three cells and discharged as three groups of four cells, by a suitable arrangement of the wiring.

If desired, a 2-volt circuit, which is sometimes very useful, by taking current directly from one cell, or from as many cells connected in parallel as may be needed to give the desired capacity; a 4-volt circuit could be obtained by connecting two cells in series, providing more capacity if need be by adding in parallel one or more such sets or groups. Remembering that when cells are connected in series each cell added increases the line voltage by approximately 2, it is seen that a wide range of voltage can be had provided, of course, that a reasonable number of cells is available; thus, a 12-cell battery will give a maximum of about 24 volts. On the other hand, when cells are connected in parallel the voltage obtained is the same as that of a single cell, while the amperage or current obtainable is the combined amperage of all of the cells; by the judicious use of series and parallel combinations of cells, therefore, a circuit of any voltage and capacity within the limits of the battery can be obtained; when designing the switchboard this fact should be borne in mind and an effort made to secure as much flexibility in the operation of the system as possible, or warranted by the conditions or requirements of the case.

Testing the Hardness of Metals in Service

To ascertain the hardness of metals under conditions of service, a machine is being built by the Palo Co., 90-94 Maiden Lane, New York City. This instrument consists of a plummet, weighing one-tenth of a pound avoirdupois, which falls one foot to the surface of the material whose hardness is to be measured. This plummet has a conical, replaceable, chill-tempered, 60-degree steel point of which several are furnished with each instrument. To the upper end of this plummet is tied a very thin silk thread which passes over a funnel-shaped piece, having slotted holes with burnished edges so that the silk passes through them with practically no friction loss. The funnel turns with a slight friction in the end of the jointed supporting brass tube. The silk thread is attached to a small, burnished ring at its lower end, the ring in turn being caught in a small trigger which can be released by a thumb-screw without jarring the instrument. The silk thread so supports the plummet that it is directly over the aperture in the base of the instrument. The base is supported at three points, two of which are controlled by a leveling screw. Small cross levels indicate the verticality of the supporting rod.

In operation, the instrument is set on the surface of the material so that the aperture in its base is concentric with the spot to be tested. The plummet is supported by the silk thread and the funnel support is gently turned until the distance from the conical point to the surface of the material to be tested is exactly one foot. When the plummet is at rest, the trigger is released by a thumb-screw, the plummet falls and makes a uniform circular indentation in the material tested. The object in releasing the plummet from the bottom of the apparatus is to avoid any disturbance in its upper support. A portable microscope then is employed to measure the diameter of the impression made by the falling plummet point. The microscope is so designed that it has sufficient illumination and magnifying power to measure easily, the diameter of the impression made, with an eye-piece micrometer.

Increased Graphite Production

H. G. Ferguson, of the United States Geological Survey, department of the interior, estimates that the production of flake graphite for 1916 was about 11,500,000 pounds, as compared with 7,074,370 pounds in 1915 and 5,220,539 pounds in 1914. Alabama furnished about 5,500,000 pounds, and the remainder came from the mines in California, Montana, New York and Pennsylvania. In all, 16 companies produced flake graphite. The imports of flake graphite, chiefly from Ceylon and Madagascar, far exceeded the domestic production. Owing chiefly to the immense demand for crucibles for use in making munitions, the better grades of flake graphite now command more than double the price at which they sold before the war.

Most of the amorphous graphite used in this country is imported from Mexico and Chosen, Korea, but a total of 2562 tons was obtained from mines in Michigan, Nevada, North Carolina and Rhode Island. Amorphous graphite is not suitable for use in the manufacture of crucibles but can be used for making lubricants, pencils, paints and foundry facings.

Made Sand Blast Machines

On page 231 of the June issue of THE FOUNDRY it was stated that certain cleaning room equipment, including four horizontal table sand-blast machines in the foundry of the Buick Motor Co. were built by the W. W. Sly Mfg. Co., Cleveland. The four horizontal table sand-blast machines were manufactured by the American Foundry Equipment Co., New York, the other equipment mentioned having been furnished by the W. W. Sly company, as stated.

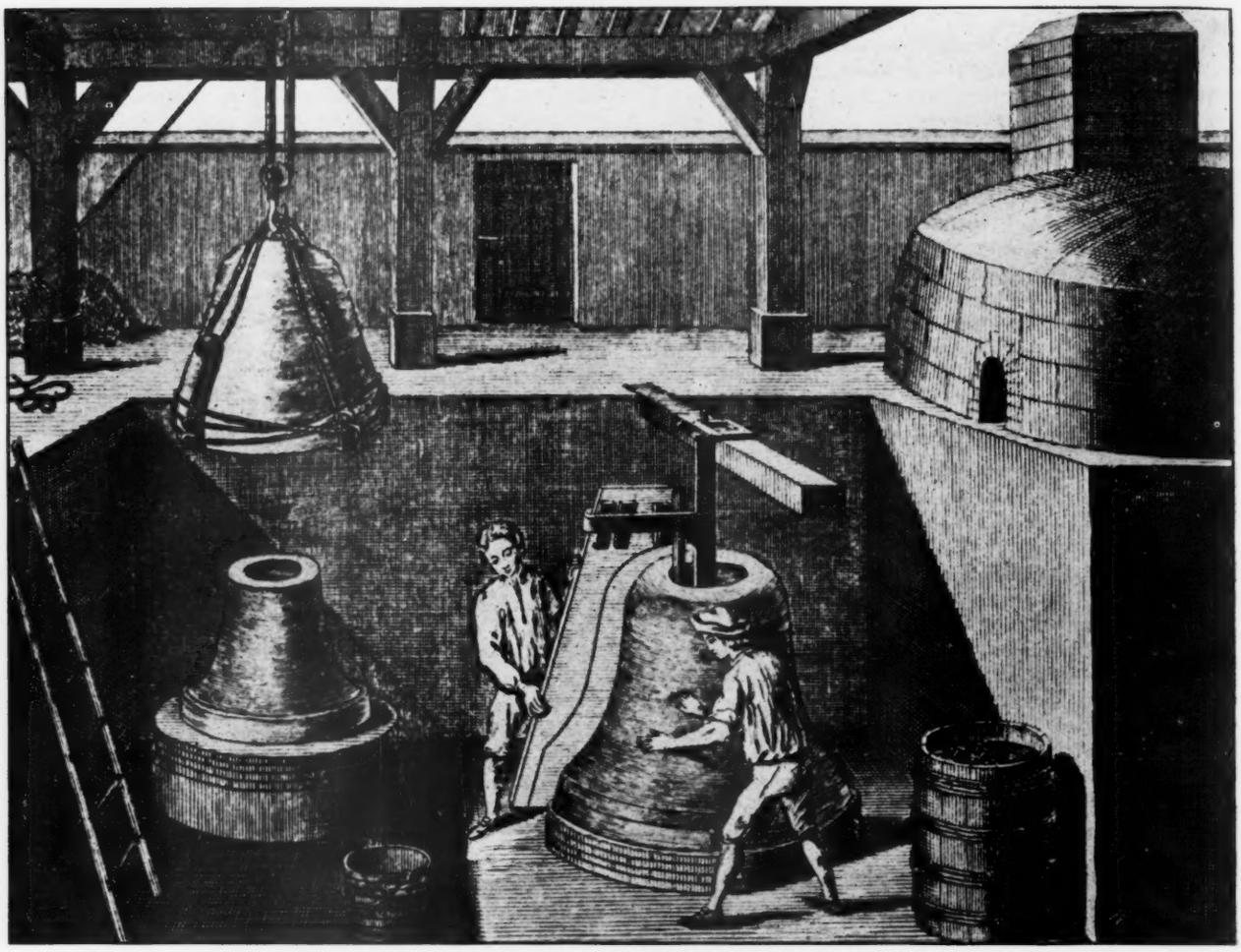


FIG. 15—CASTING BRONZE BELL IN CLAY, 1775

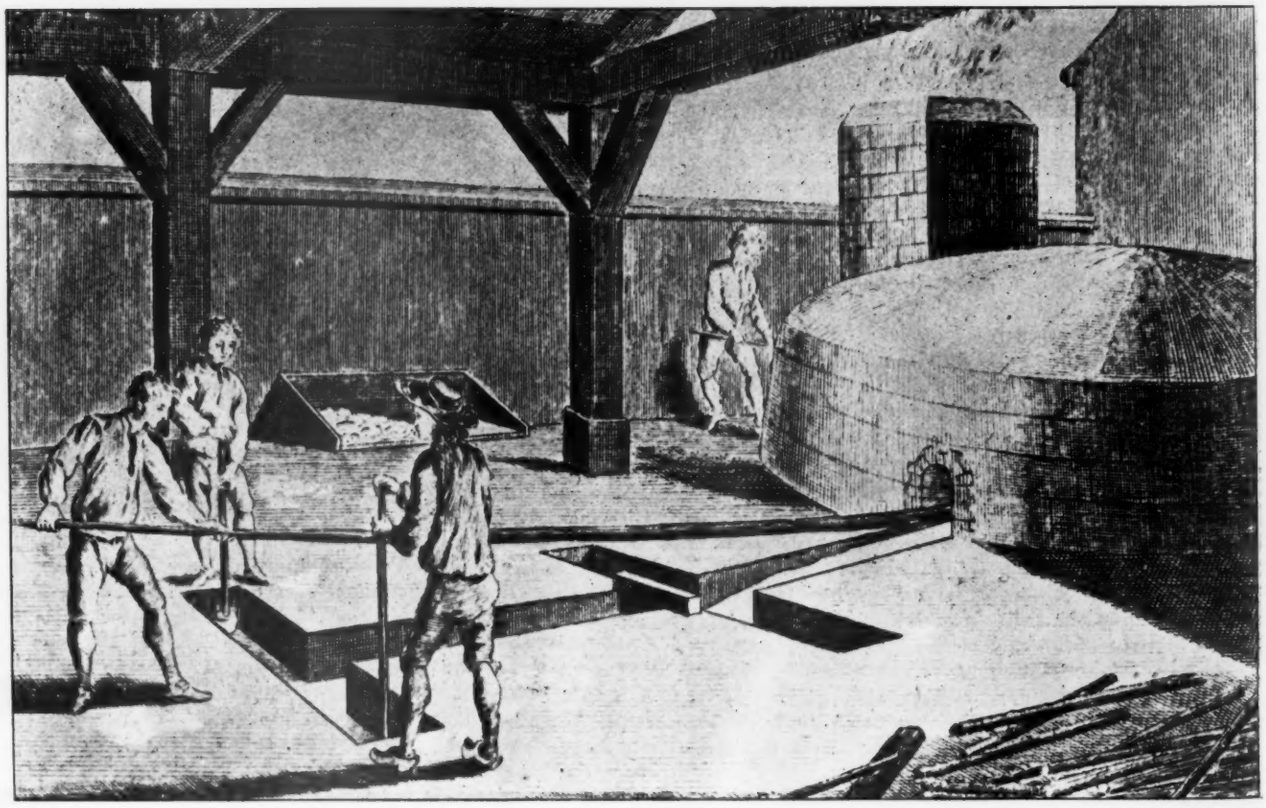


FIG. 16—TYPE OF FURNACE USED IN BELL FOUNDRY, 1775

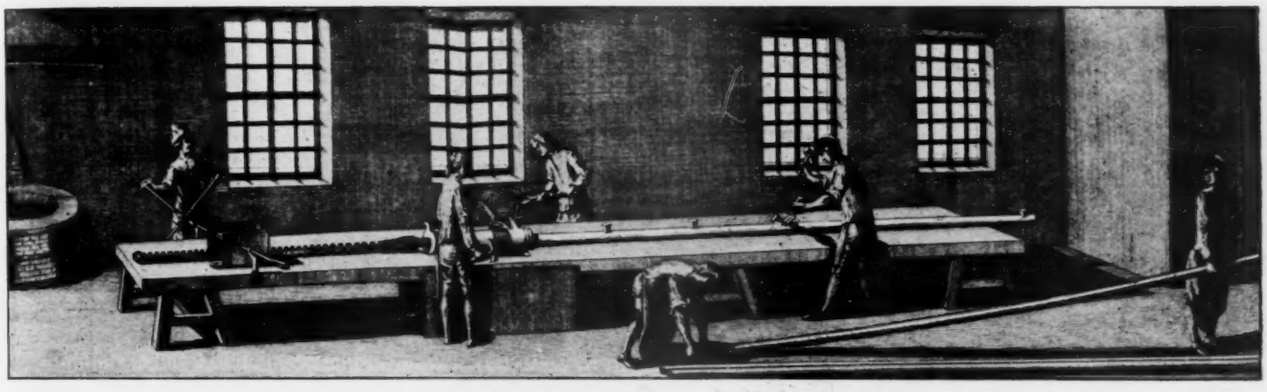


Fig. 17—Casting Seamless Continuous Lead Pipe in France in 1743

The Evolution of the Die Casting Process---II

Casting Bronze Cannon for the American Revolution—Advance of Cast Pipe, Type-Setting and Die-Casting Industries

By Charles W Pack

CASTING large bells formed an important branch of the clay or loam process of molding metal. This industry seems to have started in the monasteries. The first laymen bell founders journeyed to a place where a bell was to be cast.

The casting of a large bell is illustrated in Fig. 15. Large bells were constructed over a base in a pit. A compass on a stake was pivoted in the center of the base and to the compass was fastened a templet to give the curve of the bell. A brick core, covered with clay, into which calves' hair had been mixed was raised on the base. By revolving the compass and smallest templet the clay was formed to the dimensions of the inside of the bell or core. This was smeared with grease, and then was covered with a layer of clay which was turned by a larger templet into a clay bell.

Any inscriptions were molded on the outside of this clay bell, usually in wax. The clay bell, in turn, was smeared with grease and was first covered with fine and then with coarse clay to form a solid mantle or outside mold. The whole was then baked. After this, the mantle or cope was lifted, as shown in Fig. 15, and the clay or false bell was taken off, or if necessary, broken off. The mantle was then let down again, leaving an open space between it and the core exactly the size of the bell. The molds then were packed in the pit with sand and earth and the metal which had been melted in the furnace run into them.

A view in the furnace room is

Presented at the Cleveland meeting of the Institute of Metals, September, 1916. The author, Charles W. Pack, is with the Doehler Die Casting Co., Brooklyn, N. Y.

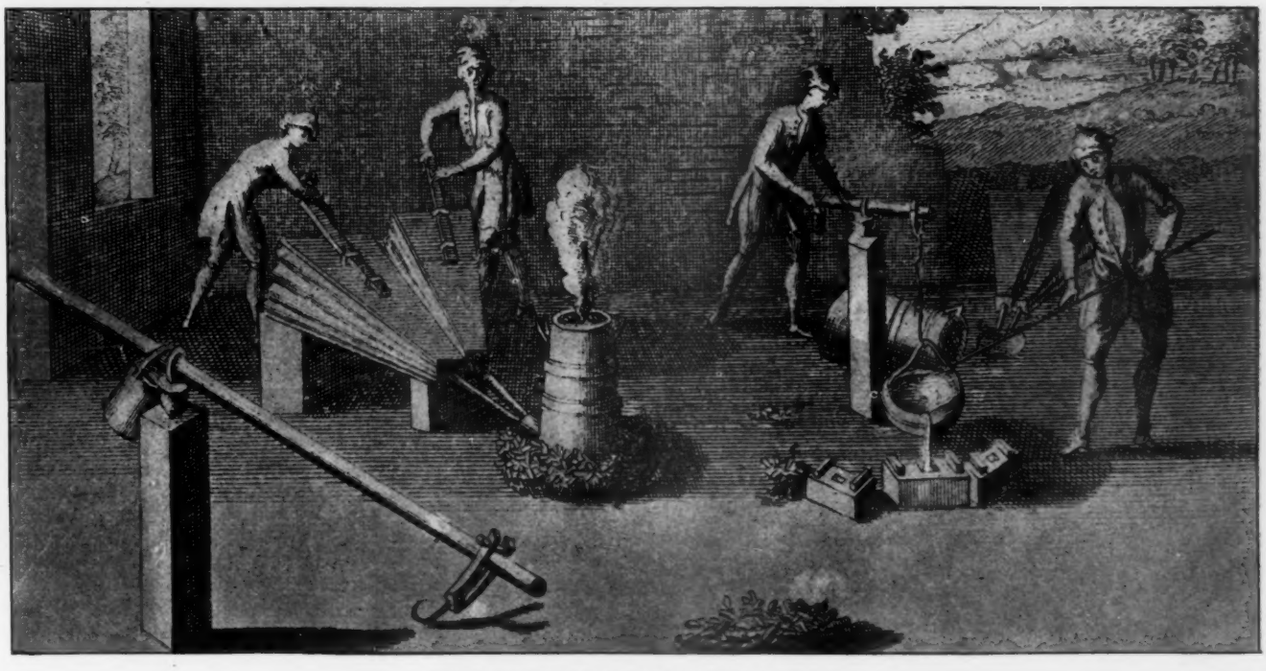


FIG. 18—REAUMUR'S FOUNDRY, 1724

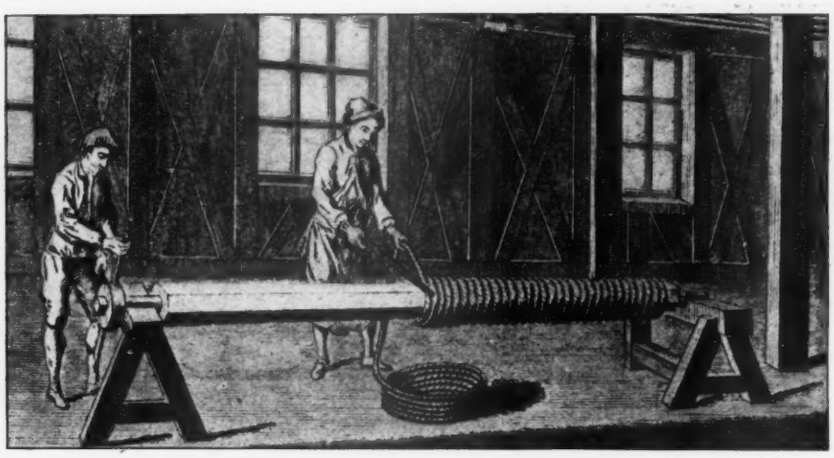


FIG. 19—CASTING BRONZE CANNON, 1775—MAKING CORE

FIG. 20—PUTTING ON FIRST CLAY FOR CORE

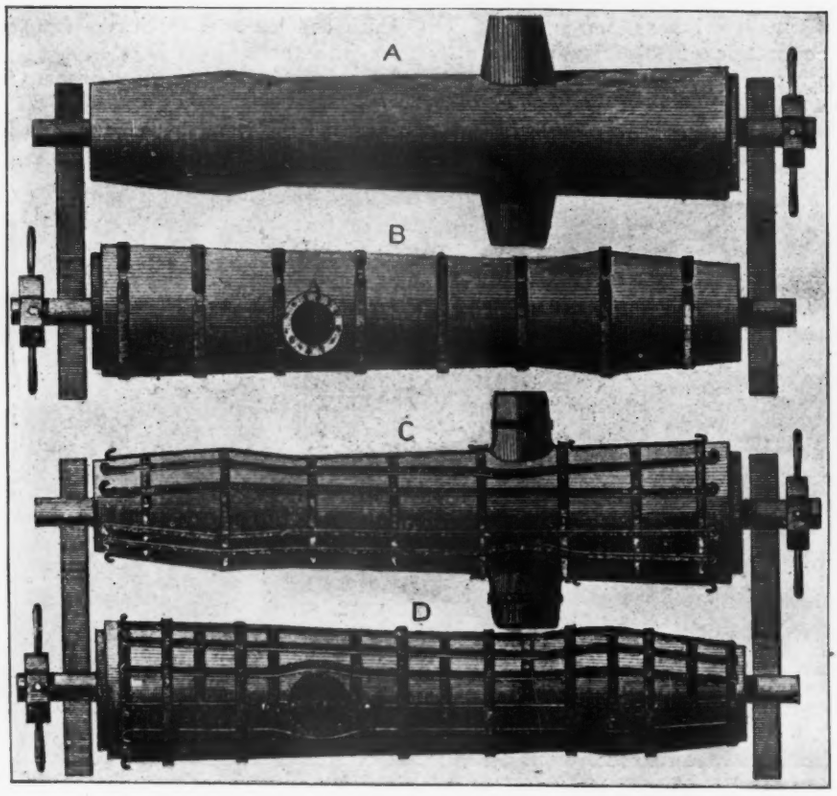


FIG. 21—PROGRESS IN APPLYING SECOND CLAY FOR CANNON MOLD

shown in Fig. 16. The metal was run through a trough into the pit below, the trough being so arranged that a number of bells could be poured in succession. The two-bell casting pictures reproduced as Figs. 15 and 16 are dated 1775, and the process illustrated undoubtedly was used for the casting of the Liberty Bell in 1776.

Early Munitions Makers

The manufacture of arms and munitions is playing such an important part in the foundries and machine shops today that it will be of more than unusual interest to study the munition shops of the eighteenth century to learn the process then in use for casting bronze cannon, some of which were used in the Revolutionary war in 1775.

Fig. 19 represents the first step in this process which may be described briefly as follows: The wooden spindle was wound with hay rope to a size approximating that of the cannon. The next step, which is illustrated in Fig. 20, was to apply clay to form the outside of the cannon which was cast solid. The bench used in applying the clay and the position of the templet is clearly indicated. The core was then greased and another layer of clay to form the outside of the mold was applied, as illustrated in Fig. 21. *A* shows the mold as it appeared after the second or outer coat of clay had been applied and the molds to form the lugs of the cannon had been attached; *B*, *C* and *D* show the method of banding the outside. Fig. 22 illustrates the mold banded and ready for the drying which is shown in Fig. 23.

Collapsible Cores

When the mold had been completely dried, the spindle and rope were withdrawn causing the inside layer of clay to collapse which was blown-out leaving the void to be filled in by the solid cannon. A view of the furnace room is shown in Fig. 24. The furnace is of the type that was used extensively during the colonial period.

Molding in sand as a commercial method began about 1708. Abraham Darby, in Wales, had been having considerable trouble in casting hollow iron vessels, when a boy by the name of John Thomas conceived the idea that the use of sand instead of clay would better let out the air from the casting and avoid the destruction of many molds. They stayed until after working hours and made some successful experiments with the new method. Thomas was later taken into partnership and the firm con-

tinued to use this plan. In England a patent for sand molding was allowed by the government in 1758.

One of the pioneers in the sand-casting art was Reaumur, the French scientist and originator of the system of temperature measurement that bears his name. A view in his foundry is shown in Fig. 18. The hand bellows, as shown in operation, and one furnace are working, the other having just been emptied. The man at the right is pouring-off the molds. The unique crane arrangement for handling the crucible used by Reaumur is shown in the foreground at the left.

Fig. 26 is a view of a French statuary shop, dated 1760. Here the molds were carved by hand, assembled and poured. The most distinctive feature of this illustration is the peculiar method of gating shown at the left. A series of gates at different heights of the casting was provided. Pouring was begun at the lowest gate which was plugged and the gate above then was poured and plugged, and so on until the casting was filled. The object of this method of gating was undoubtedly to insure the removal of gases and to reduce segregation to the minimum.

Metal Molds

There seems to be little doubt but that the metal mold was first used for casting type since the advent of printing brought with it a demand for a cheap method for producing type. Pewter had come into extensive use for tableware during the fifteenth century and was highly fashionable during the colonial period. This industry provided another opening for the use of metal molds.

Seamless lead pipe was made in metal molds during the first half of the eighteenth century. Fig. 25, reproducing a picture dated 1775, shows a shop where pewter kettles were cast. The furnace is in the background. Two men are shown pouring a pot at the left. The heavy threaded apparatus used for withdrawing the core also is shown at the left. The two men at the right appear to be broaching the hole to provide a snug fit for the cover. A finished casting is in the foreground.

Seamless Lead Pipe

Fig. 17 shows a shop where seamless lead pipe was cast in 1743. The mold was constructed in two halves and was fastened together by clamps. The core was fastened to a rack operated by a pinion shown at the left. The metal was poured through the opening of the mold, and when the metal had set sufficiently, the

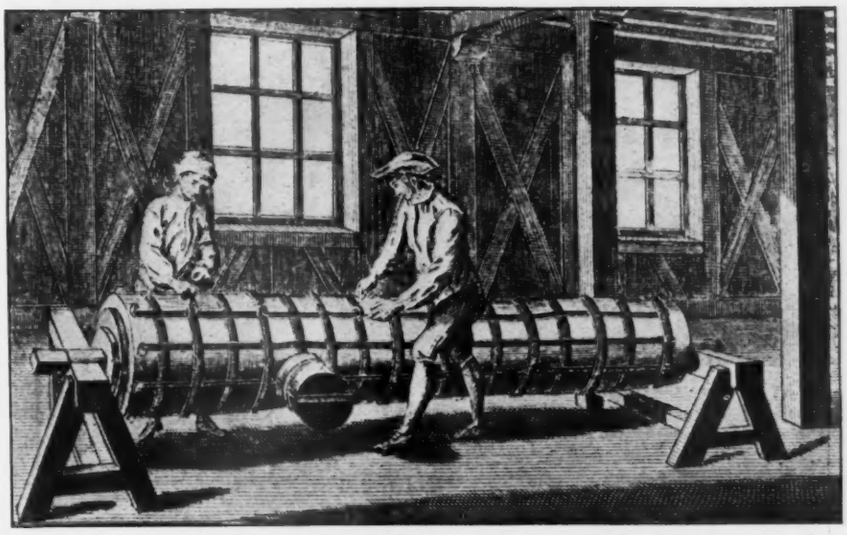


FIG. 22—BONDING SECOND CLAY FOR CANNON

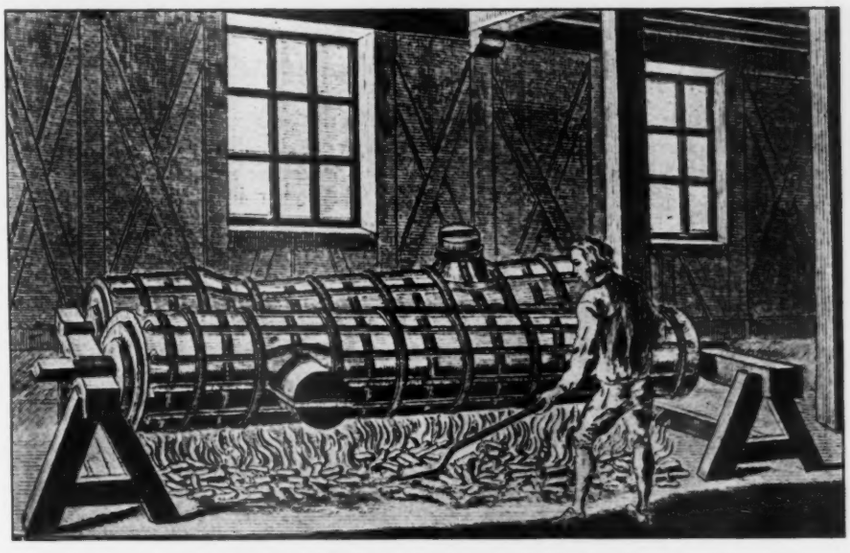


FIG. 23—BAKING THE BONDED MOLD

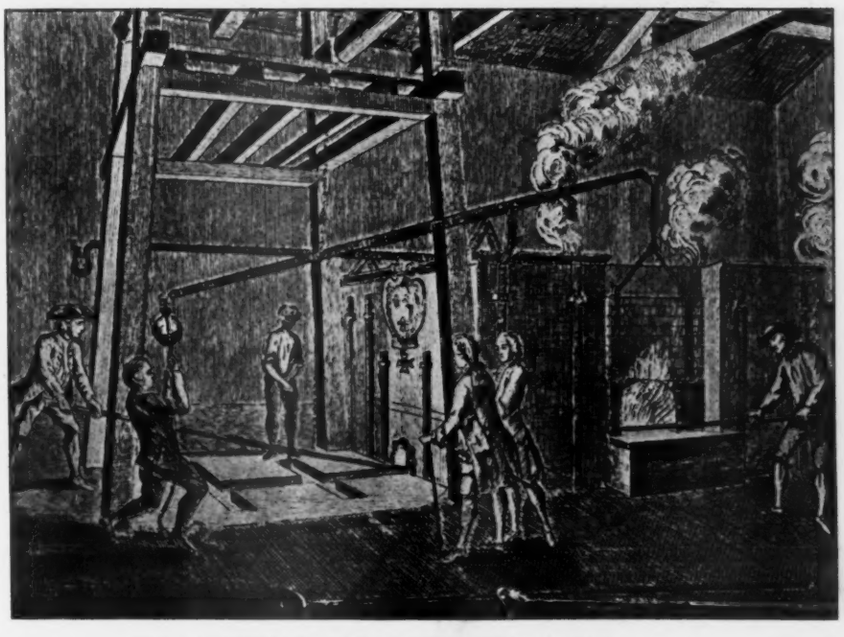


FIG. 24—FURNACE FOR MELTING METAL FOR CANNON

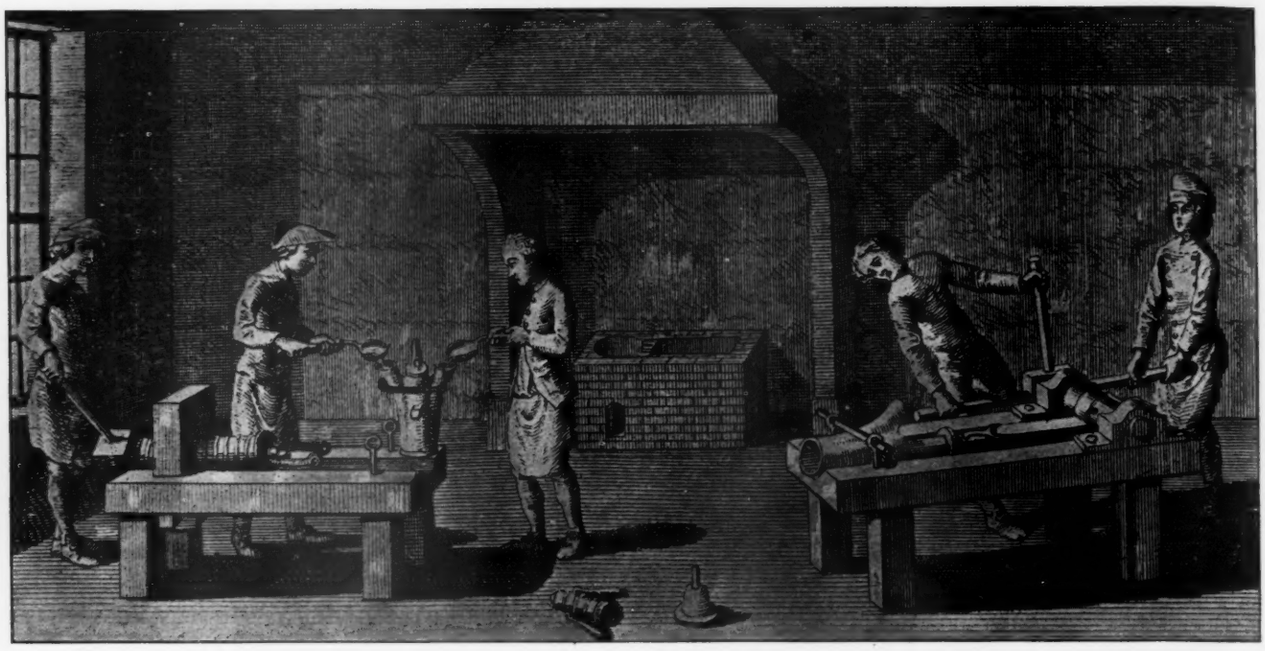


FIG. 25—CASTING PEWTER, 1755

core was withdrawn, the clamps removed and the mold opened. The casting then was moved down the bench to another position. To make the next piece, one end of the previous casting was clamped in the mold, the core then was replaced and the metal poured. Conditions were so regulated that the metal running into the mold melted the end of the previous casting and joined with it, forming a seamless tube. One man worked the rack and pinion for withdrawing the core, two men placed the clamps in position and poured, one man cut off the gates and the other two men removed the finished product. This method, although much slower than the modern extrusion process, answered the purpose very nicely and must be admitted to be a rather ingenious process which required very little and inexpensive equipment.

The Type Casting Industry

The method owes its origin and early development to the type-casting industry established as a most necessary factor to the successful introduction of printing. A type-casting outfit used about 1683 is shown in Fig. 27. The mold was held in one hand by a small leather mold guard and the metal was poured with the other hand. The metal was melted in a small iron pan. Fig. 28 is a view in an American type-casting room with the entire family at work. The picture from which this was reproduced is dated 1800.

Work was begun on the automatic type-casting machine early in the nineteenth century. Church's type caster was an English invention of 1822. It was claimed to be capable of casting 75,000 pieces of type an hour by casting a whole font at each operation. Following this invention came many others too numerous to mention. In 1886 the first linotype

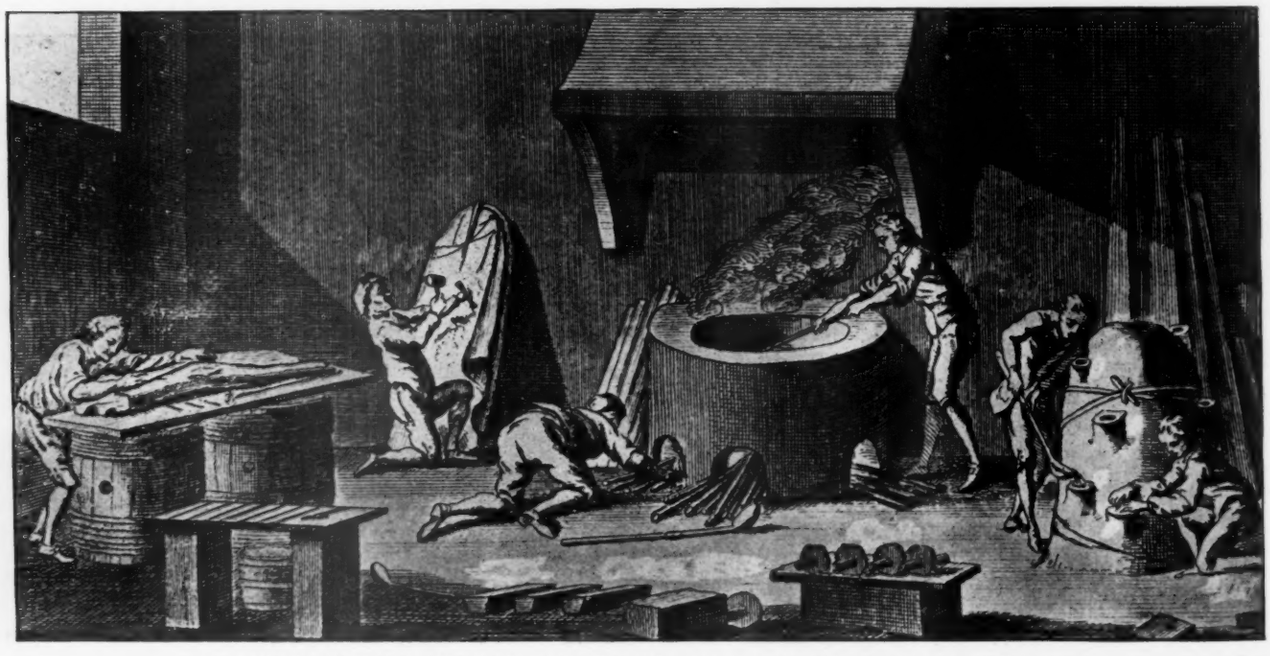


FIG. 26—CASTING IN CLAY, 1760, FRANCE—NOTE POURING GATES ON MOLD

machine with independent matrices was installed. When the matrices have been assembled, forming a complete mold, the metal, which is kept in a fluid state, is automatically forced into the mold by a cylinder and piston arrangement submerged in the metal.

This method of casting, although an important feature of this machine, had been used as early as 1849 for casting type and bullets, as indicated by patent issued to J. J. Sturgis that year. During the second half of the nineteenth century many casting machines were patented using the plunger-type casting principle, but varying in design.

The first record of the application of this principle to the manufacture

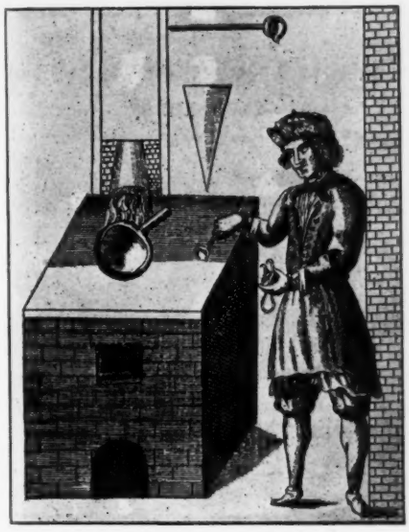


FIG. 27—TYPECASTING IN 1683

of die-castings as understood today, appears in a patent issued to B. H. Dusenbury in 1827 for a plunger-type machine used for casting babbitt bearings. Machines of this type, with varying designs, were used for casting tin and lead alloys on a small scale, but the die-casting did not receive recognition as a standard metallurgical product until 1907. The Doehler machine was patented during that year and was widely adopted. The tin and lead alloys were found to be too soft for most purposes and a zinc base alloy was adopted.

Die-castings have been employed for many purposes, among which may be mentioned housings on magnetos; tone arm, elbow and sound box for talking machines; automobile oil pumps, wing nuts, horn, speedometer and many other parts of motor vehicles where high tensile strength is not essential; internal and external parts of gum, soap, stamp and cigar vending and labeling machines; and electrical devices, such as oscillating fans, signaling devices, etc.

Specifications for Wood Patterns

By J. F. Shea

To avoid confusion and misunderstanding when quoting prices on pattern work, and to serve as a guide for making its patterns, the Lake Torpedo Boat Co., Bridgeport, Conn., has prepared specifications covering all of its contract model work, which are as follows:

Owing to the large number of different designs of castings we are compelled to use, the shrinkage varies greatly, and each job of any size and importance is a problem in itself, and should be treated so that the castings will conform to the drawing.

However, unless otherwise notified, the following general instructions should apply—

	Shrinkage, In. per ft.	Colors of patterns.
Composition	5/32	Black prints
Aluminum	5/32	Black prints
Cast iron	1/10	Yellow prints
Lead	3/16	Yellow prints
Cast steel	3/16	Yellow prints
Malleable iron	1/8	Yellow prints
Joint on loose pieces.		Red

We have herewith specified three grades of patterns, namely, *A*, *B* and *C*.

The number of castings required from any pattern will determine its grade, and will be shown on the drawing.

Grade A

These patterns and core boxes must be made of mahogany, joints to be screwed and glued.

Fillets should be cut in the job wherever possible, otherwise leather fillets should be used. Screw holes must be counter-bored and plugged.

These patterns must be provided with brass dowels and rapping plates. The cores should be shown by shellac wherever possible. Loose pieces must be dovetailed in place. The patterns must have at least four coats of shellac.

The workmanship should be the best.

Grade B

Pattern and core boxes should be made of well seasoned white pine, except all wearing parts, which should be of mahogany. Loose pieces to be made of mahogany and dovetailed in place wherever possible.

Wood dowels are permissible.

Screw holes to be counter-bored and plugged.

All joints to be well-glued and nailed.

Core must be shown wherever possible.

Wood or leather fillets can be used.

The pattern should have at least three coats of shellac.

Workmanship good.

Grade C

Patterns intended for one or two castings only must be made to check exact with the drawing; otherwise as cheap as foundry permits.

The Refractories Manufacturers' association, with headquarters at 220 South Michigan avenue, Chicago, has endowed a fellowship in the Mellon Institute of Industrial Research, Pittsburgh, which is operated in connection with the University of Pittsburgh. The membership of the Refractories Manufacturers' association is constituted of producers of silica, chrome, magnesite and fire brick. The Mellon institute will make an investigation of the problems of brick manufacture and the results undoubtedly will prove beneficial to the producers of these refractories and to the users, as well.

Castings from Acid and Basic Electric Steel

Owing to a typographical error in the article entitled "Castings from Acid and Basic Electric Steel", by A. Walter Lorenz, published in the June issue of THE FOUNDRY, page 220, the statement was made "it is only necessary to raise this manganese 0.50 per cent to secure a product as good as the average con-

FIG. 28—TYPECASTING IN 1800

verter product of 0.60 to 0.70 per cent manganese." This should have read "it is only necessary to raise this to 0.50 per cent." The sentence as printed conveys the impression that electric steel must contain more manganese than converter steel to be of equal quality. As a matter of fact, for equal physical characteristic, electric steel requires less manganese than converter steel. Electric steel containing 0.40 to 0.50 per cent manganese is equal to converter steel of 0.60 to 0.70 per cent manganese both in soundness and strength.

An alloy of 85 per cent nickel and 15 per cent chromium, drawn into wire 0.016 inch in diameter, has a resistance of 2.3 michroms per foot. Nickel and chromium alloys are adapted for use at temperatures of from 800 to 1000 degrees Cent.

An alloy of 90 per cent nickel and 10 per cent chromium has a melting point below that of copper and a resistance nearly 50 times that of copper.

Testing Society Considers New Specifications

Committee Reports Submitted at Atlantic City Meeting Extend Scope of Standardization in Producing and Testing Metal Products

TENTATIVE specifications for soil pipe and fittings and for railroad malleable iron castings were submitted at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 26 to 29. The committee on cast iron, of which Richard Moldenke is chairman, reported that the constantly increasing sulphur content of gray iron castings has resulted in a demand for more latitude in this direction in the specifications of the society. Therefore, it was decided to increase the maximum sulphur limit in light castings from 0.08 to 0.10 per cent. The change from general to special standard specifications for malleable iron castings, predicted last year, has arrived sooner than was expected. The revised specifications adopted in 1915 did not satisfy the demand for all classes of malleable castings. The committee of the Testing society, in co-operation with a similar committee of the American Foundrymen's association, has prepared proposed specifications for railroad malleables and a recommendation was made that the present specifications be retained for the general run of work. The special requirements for conveyor chain links will next be taken up by the sub-committee on malleable cast iron and it is probable that next year tentative specifications will be presented.

Revising Cylinder Standard

The sub-committee on cylinders is at work on the revision of the present standard specifications for cast iron locomotive cylinders, which are to be extended to embrace piston-valve bushings, piston-valve packing rings, piston-valve bull rings, cylinder bushings, piston packing rings and piston head or bull rings. This committee is working with a similar committee from the Master Mechanics' association and it is believed the revision shortly will be completed.

The sub-committee on cast iron car wheels is continuing its work of revising the existing standards and another committee has undertaken the consideration of the standard screen scale for testing sieves, recommended for adoption by the United States Bureau of Standards. The subject of molding sand will be taken up in the near future with the committee on refractories of the Testing society and a committee from the American Foundrymen's association.

One session was devoted to the consideration of nonferrous metals and the report of the committee on nonferrous metals and alloys, presented by William Campbell, chairman, included tentative specifications for nonferrous alloys for railway equipment in ingot, castings and finished car and tender bearings, as well as the revision of the standard specifications for spelter. Other tentative specifications presented included brass for forging rods and free-cutting brass rods for use in screw machines.

W. M. Corse, chairman of the sub-committee on sand-cast metals and alloys, reported that a large amount of interesting data on the following alloys had been collected: Copper, 88 per cent; tin, 10 per cent and zinc 2 per cent; manganese bronze; copper, 80 per cent, tin 10 per cent and lead 10 per cent; copper, 90 per cent and aluminum, 10 per cent, and aluminum, 92 per cent and copper, 8 per cent. The report of the tests of these alloys is given elsewhere in this issue.

G. H. Clamer, chairman of the sub-committee on white metal, stated that it is highly desirable that no specifications for white metal shall be recommended until standard methods of analysis and sampling are agreed upon.

In the proposed revision of the standard specifications for spelter, the limit for cadmium in high grade spelter was increased from 0.05 to 0.07 per cent. The limit for lead in prime western grade spelter was increased from 1.50 to 1.60 per cent and the limit for iron was increased from 0.06 to 0.08 per cent. Changes also were made in the paragraphs relating to the method of sampling.

Alfred D. Flinn and Ernst Jonson were the joint authors of a paper entitled, "Inspection of Brass and Bronze".

Papers on Wrought Brass

In his paper on the "Interior Surface Defects on Brass Condenser Tubes as a Cause for Corrosion". W. Reuben Webster, stated that it is the belief of some engineers that defects on the interior surface of brass condenser tubes act to accelerate corrosion and accordingly their presence, even to a small degree, should not be tolerated. Extended observation has failed to furnish a basis for such belief. The variety of corrosion which exhibits itself in local pitting resulting in perforation, takes place independently of any interior defects which may exist and no tendency of the pitting to localize at a surface defect has been observed. Productions and photographs of the interior surfaces or corroded tubes, both with and without defects of any character, were shown, which clearly indicates that corrosion takes place independent of these defects.

Other papers presented included the following: "The Hardness of Hard-Drawn Copper," by E. H. Peirce; "The Electrolytic Determination of Tin on Tinned Copper Wire," by George G. Grower; "Light Versus Heavy Reduction in Cold-Working Brass", by W. Reuben Webster, and "The Testing of Sheet Brass", by Charles H. Davis.

Tentative Specifications for Soil Pipe and Fittings

1.—The cast iron from which the pipe and fittings are made shall be of such composition, and the conditions of manufacture so maintained, that the castings will be of uniform physical character, close-grain, not hard, brittle nor difficult to cut with file or chisel.

2.—(*a*) When pipe or fittings are to be coated, coal tar pitch shall be used, which shall contain sufficient oil to make a smooth coating. The pitch shall be tough and tenacious when cold, and not brittle nor having any tendency to scale.

(*b*) The varnish shall be heated to about 300 degrees Fahr., and shall remain at this temperature during the time the casting is immersed.

(*c*) Each casting shall be heated to a uniform temperature of about 300 degrees Fahr. immediately before it is dipped, and shall possess this temperature at the time it is put in the bath.

(*d*) Each casting shall remain in the bath at least two minutes.

(*e*) Fresh pitch and oil shall be added when necessary to keep the mixture of the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch whenever the accumulation of sand or carbonaceous matter renders this desirable, as can be seen by the adhering solids to the under side or lower ends of the castings.

(*f*) After being coated the pipe and fittings shall be carefully drained of the surplus varnish.

Chemical Properties and Tests

3.—Drillings taken from the fractured end of the arbitration test bar shall not contain over 0.10 per cent of sulphur.

Physical Properties and Tests

4.—From each melt of metal not less than three test specimens shall be poured, the first of which shall be poured within five minutes after the first ladle is tapped and the remainder at intervals not exceeding one hour throughout the melt.

5.—The mold for the arbitration bars is shown in the accompanying illustration. The bottom of the bar is $\frac{1}{16}$ inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a

(*Continued on page 294*)

Presented at the annual meeting of the American Society for Testing Materials.

Results of Tests of Sand-Cast Metals and Alloys

Data From Authorities on Nonferrous Metals Show Physical Properties of Five Important Alloys—No Specifications Were Submitted

For the purpose of accumulating data on various alloys from reliable sources, a sub-committee of the general committee on nonferrous metals and alloys of the American Society for Testing Materials, has obtained information from a number of expert brass foundrymen on the following alloys:

1—Copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent.

2—Manganese bronze.

3—Copper, 80 per cent; tin, 10 per cent and lead, 10 per cent.

4—Copper, 90 per cent and aluminum, 10 per cent.

5—Aluminum, 92 per cent and copper, 8 per cent.

The appended reports from the different authorities, were presented at the annual meeting of the society, held at Atlantic City, June 26 to 29, by W. M. Corse, secretary of this sub-committee.

No attempt was made to prepare specifications, the data having been presented as results which can be obtained when these alloys are cast by the methods described. The report stated, that it is a well-known fact that these physical properties, while comparative for the alloys investigated, cannot be expected to represent the physical properties of the metal in a casting. The results given cannot be used by engineers to calculate the strength of the materials, except with a liberal factor of safety, because the physical properties of a casting are largely dependent on its size and form. In the opinion of the sub-committee, the value for tensile strength and yield point of actual castings are only 50 per cent of those values obtained with these test bars.

The 88-10-2 Alloy

Data from L P Webbert

THIS alloy is commonly known as the 88-10-2 alloy, government bronze, United States navy gun bronze and government composition *G*. In England it is known as admiralty gun metal, gun metal and gun bronze. The alloy contains copper, 87 to 89 per cent; tin, 9 to 11 per cent, and zinc, 1 to 3 per cent.

The impurities present in this alloy are iron, not exceeding 0.10 per cent; sulphur, not exceeding 0.05 per cent, and lead, not exceeding 0.50 per cent. Aluminum and antimony are not allowed to be present in this alloy even in small quantities.

The presence of a small quantity of lead, not over 0.50 per cent, improves the machining qualities of this metal.

The physical properties of this alloy are as follows:

Specific gravity at 20 degrees Cent. (68 degrees Fahr.)	8.7
Weight per cubic inch, pounds	0.314
Brinell hardness number, 500 kg. load, 10 mm. ball (sand-cast metal, unannealed)	70
Scleroscope hardness number	12–15

The highest tension test observed, using this type of test specimen, was 58,450 pounds per square inch with an elongation of 2 inches of 55.5 per cent. Specifications allow a minimum tensile strength of 33,000 pounds per square inch and a minimum elongation of 2 inches of 14 per cent.

Linear contraction from liquid to solid, using a bar 12 by 1 by 1 inch, inches per feet, 0.13.
Melting point, 995 degrees Cent., (1825 degrees Fahr.)
Casting temperature, 1175-1245 degrees Cent. (2150-2275 degrees Fahr.)
Thick castings take the lower temperature. Thin castings take the higher temperature.

The test specimen most convenient to attach to castings is shown in Fig. 1. This type of specimen receives the same heat treatment as the casting and is free from defects.

A test specimen 0.505 inch in diameter, as shown in Fig. 1, would represent

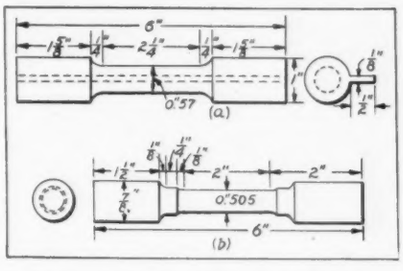


FIG. 1—TEST SPECIMEN FOR 88-10-2 ALLOY

quite closely the strength of a casting of ½ inch thickness. A test specimen 0.798 inch in diameter, similar to the specimen of 0.505 inch in diameter, would give a lower tensile strength and would represent quite closely the strength of a casting ¾ inch thick.

The designer of a casting should note that the average strength of a thick casting in pounds per square inch is lower than that of a thin casting. This is due to the fact that the surface of a casting, commonly called the skin, possesses the highest tensile strength. From the skin inward the tensile strength and elongation decrease. A test specimen of the type shown in Fig. 1 attached to a casting may give a tensile strength of 40,000 pounds per square inch, whereas a test specimen cut from the interior of the same casting may give a tensile strength as low as 25,000 pounds per square inch. The designing engineer should pay particular attention to those parts of a casting where the skin is removed in machining, leaving the weaker metal.

The test specimen, as shown in Fig. 1, attached to a casting is practically a cast-to-size test coupon and gives a higher tensile strength than the average

FIG. 2—SPECIMENS OF 88-10-2 ALLOY

strength of the casting. The specimen receiving the same heat treatment as the casting affords a means of examining the heat treatment received by the casting. Fig. 2 shows the appearance of the surface of eight test specimens, selected from a large number of castings, after being pulled. These castings were made in dry sand and were allowed to cool in the mold. The specimens are arranged to show the relation existing between the condition of the surface of the pulled test specimen and the heat treatment received. It has been shown that a similar relation exists between the surface of a steel test specimen after being pulled and the heat treatment received. The casting temperatures of specimens Nos. 6, 7 and 8 were too high. With specimen No. 1, the heat introduced into the mold approaches the amount necessary to anneal the casting properly. Beyond specimen No. 1, the specimens show decreasing tensile strength and elongation, and at the extreme end, if we could complete the arrangement of specimens, we find specimens showing a grayish fracture with very low elongation and showing an almost smooth test specimen.

The accompanying table gives the physical properties of the specimens.

PHYSICAL PROPERTIES OF SPECIMENS SHOWN IN FIG. 2

Specimen No.	Yield point,[1] pounds per square inch	Tensile strength, pounds per square inch	Elongation in 2 inches, per cent
1	18,500	54,500	53
2	18,000	52,800	50
3	19,500	52,000	61
4	17,500	51,000	56.5
5	17,000	50,300	75.5
6	17,500	47,400	49
7	18,500	41,300	29
8	18,500	40,000	29.5

[1]The dividers were used in obtaining the yield point. The values given are approximate.

Properties of Manganese Bronze

Data from N K B Patch

THE chilled cast bar used was made from a 1-inch square bar poured in an open chill and then machined to size. The sand cast bar was cut from the standard A. S. T. M. No. 4 bar with three coupons. Following are the physical properties of the bars:

	Sand-cast	Chill-cast
Tensile strength, lb. per sq. in.	70,000–75,000	75,000–80,000
Elongation in 2 in., per cent	22–30	25–32
Brinell hardness	109–119	119–130
Specific gravity	8.4	.....
Wgt. per cu. in., lb.	0.30	.....
Electric conductivity, per cent, about	22	.....
Modulus of elasticity, lb. per sq. in.	14,000,000	.....
Shrink., in. per ft.	¼	.....

The Physical Properties of Manganese Bronze

Data from G. H. Clamer

The chemical analyses of eight typical manganese bronzes are as follows:

	Maximum, per cent	Minimum, per cent	Average, per cent
Copper	59.80	57.44	58.72
Zinc	40.26	37.59	39.05
Tin	1.03	0.59	0.79
Iron	1.39	0.80	1.06
Manganese	0.05	0.03	0.038
Aluminum	0.80	0.19	0.47
Lead	0.20	0.05	0.12

For tension tests, the sand-cast specimens were taken from the bottom of regulation wedge-form of test block, and the chill samples were cut from the bottom of ingots cast in open molds. The physical properties determined are as follows:

Tensile strength, pounds per square inch:
Sand-cast 70,000-75,000
Chill-cast 75,000-80,000
Elongation in 2 inches, per cent:
Sand-cast 22–30
Chill-cast 25–32
Weight, sand cast, pounds per cu. in. 0.3009
Shrinkage, inches per foot ..... ¼

It is noticeable that the tensile strength of the chill cast specimen exceeds that of the sand-cast by 5000 pounds.

Conductivity and Hardness of Manganese Bronze

Data from J. L. Jones

Tests for the electrical conductivity for manganese bronze gave the following results:

Degrees, Cent.	Per cent
23	27.7
21.8	27.4
21.6	27.5

Results of 22 tests for Brinell hardness on 3 samples were as follows:

Maximum	113.6
Minimum	96.3
Average	105.0

Strength and Elongation of Manganese Bronze Specimens

Data from J. A. Capp

Manganese bronze castings were supplied in the form of cylindrical bars about 1½ inches in diameter and 24 inches long. They were machined to about 1 inch in diameter and 8 inches long between shoulders for extensometer tests; or about ½ inch in diameter and 2 inches long between shoulders for commercial tests. The results are given in the accompanying table.

RESULTS OF TESTS ON MANGANESE BRONZE BARS MADE BY J. A. CAPP

	Extensometer test			Commercial test			
Bar No.	Elastic limit, pounds per square inch	Modulus of elasticity, pounds per square inch	Elongation in 8 inches, per cent	Yield point pounds per square inch	Tensile strength pounds per square inch	Elongation in 2 inches, per cent	Reduction of area, per cent
9902 *B*	16,000	12,390,000	31.6	26,000	69,650	32.5	40.8
9902 *B*	15,000	12,900,000	27.5	.....	.....	....	....
9902 *A*	21,400	.....	27.2	25.000	67,940	42.0	54.8
9902 *A*	16,000	13,000,000	27.8	.....	.....	....	....
9908 *B*	23,000	13,300,000	10.6	29,000	80,420	26.5	28.5
9908 *A*	22 900	.....	6 6	26,000	70,900	14.5	22.4

Properties of the 80-10-10 Alloy

Data from N K B Patch

THE physical properties for both sand-chill and chill-cast specimens of the 80-10-10 alloy are given in the accompanying table. Specimen No. 1 was tested by the Lumen Bearing Co. This alloy contained 0.2 per cent of phosphorus. The sand-cast specimen was made from a cast-to-shape standard 2-inch by 0.505-inch test bar. Tests on the chill-cast specimen were made on a 1-inch square test bar machined to a standard 2-inch by 0.505-inch bar, cast in an iron mold.

Specimen No. 2 was tested by the Ajax Metal Co. The tests on this specimen were made from a block cast in sand, the specimen being machined before testing. The test block was gated at the bottom, the upper part of the wedge being a cross-section to act as an adequate riser for the poured metal. Specimen No. 3 was tested by the Titanium Alloys Co. Tests on sand-cast specimens were made on bars cast-to-shape. No record was made of the bar used for the chill cast.

Specimen No. 4 was tested by the Westinghouse Electric & Mfg. Co. This alloy contained 0.35 per cent of phosphorus. Tests were made from a standard 2-inch by 0.505-inch test bar machined from a sand-cast specimen. Hardness tests were made on a specimen 2 inches in diameter by ¾ inch thick.

It should be noted that the variation in elongation and reduction of area as given by the different tests would indicate some slight variation in the analyses or composition of the material. This may be explained by the difference in the amount of phosphorus used as a

deoxident or it may be possible that some of the manufacturers use another deoxidizing agent which has no hardening effect.

The tensile strength of sand cast specimens ranged from 26,000 to 37,000 and that of the chill cast specimens varied from 30,000 to 42,000 pounds.

Results of compression tests on cylinders 1 inch long and 1 square inch in cross-section, machined from bars about 1½ inch square, are expressed in terms of load giving compression of 0.1 per cent and compression resulting from a load of 100,000 pounds per square inch. The load is given in pounds per square inch and the compression in per cent, as follows:

	Specimen No. 1	Specimen No. 5
Load giving compression of 0.1 per cent, lb. per sq. in.	19,500	19,000
Compression at load of 100,000 lb. per sq. in., per cent	12	15

Various other physical properties were as follows:

	Specimen No. 1	Specimen No. 5
Brinell hardness	90–100	95–105
Scleroscope hardness	....	25
Shrinkage, in. per ft.	0.22	0.22
Weight per cu. in., lb.	0.27	0.27
Specific gravity at 20 degrees Cent.	7.5	7.5
Coefficient of friction	0.0018	.....
Coefficient of expansion, per degrees Cent.	0.0000171	.....
Electric conductivity at 20 degrees Cent., per cent.	....	18.39* 15.47†
Endurance Tests in White-Souther Machine		
Revolutions at 36,000 lb. per sq. in., max.		1,000,000
Revolutions at 27,000 lb. per sq. in., max.		10,000,000

*By mass.
†By volume.

It is noticeable that the data for the two specimens correspond very closely in practically every detail.

PHYSICAL PROPERTIES OF THE ALLOY; COPPER, 80 PER CENT; TIN, 10 PER CENT; ZINC, 10 PER CENT

Physical property	Specimen No. 1	Specimen No. 2	Specimen No. 3	Specimen No. 4	Average	Minimum	Maximum
Sand-Cast							
Tensile strength, lb. per sq. in.	26,000–32,000	33,130	30,000–37,000	30,000*	31,407	26,000	37,000
Yield point, lb. per sq. in.	21,000–26,000	.....	16,000–23,000	20,000*	21,200	16,000	26,000
Elongation in 2 in., per cent	4–8	28	5–18	8	13.6	4	28
Reduction in area, per cent	4–9	28.08	6–16	9	12.02	4	28.08
Brinell hardness	61–70	.....	55–60	71	63	55	71
Specific gravity	8.9	8.8†	9.0	8.70	8.85	8.7	9.0
Wght. per cu. in., lb.	0.322	0.3182	0.33	0.314	....	....	....
Shrinkage, per ft., in.	0.125	0.125	0.125	0.122	....	....	....
Elastic limit in compress., lb. per sq. in.	15,000	23,000	1,150–1,200	.....	.....	.....	.....
Elastic limit in tension, lb. per sq. in.	.....	19,020	.....	13,500	....	....	....
Compression per sq. in., at 15,000 lb. in., per in.	0.001	.....	.....	.....	....	....	....
Compress. per sq. in. at 50,000 lb. in., per in.	0.100	.....	.....	.....	....	....	....
Compress. per sq. in. at 100,000 lb. in., per in.	.....	.....	0.30–0.35	.....	....	....	....
Coefficient of expansion, per deg. Cent. from 1-100	.....	.....	0.0000188	0.0000187	....	....	....
Electric conductivity, per cent	.....	.....	.....	6.5	....	....	....
Resistance, microhms per cu. in.	.....	.....	.....	9.656	....	....	....
Melting point, deg. Cent.	.....	.....	.....	872	....	....	....

*Average.
†Calculated from weight per cubic inch of 0.3182 lb.

CHILL-CAST							
Tensile strength, lb. per sq. in.	36,000–42,000	.....	30,000–33,000	.....	35,250	30,000	42,000
Yield point, lb. per sq. in.	23,000–29,000	.....	.....	.....	26,000	23,000	29,000
Elongation in 2 in., per cent	2–6	.....	4–7	.....	4.5	2	7
Reduction of area, per cent	1–6	.....	.....	.....	3.5	1	6
Brinell hardness	80–89	.....	.....	.....	85	80	89

Ten Per Cent Aluminum Bronze

Data from W. M. Corse

The chemical composition of three specimens was as follows:

	Specimen No. 1. per cent	Specimen No. 5. per cent	Specimen No. 13. per cent
Copper	90	89	90
Aluminum	10	10	9.9
Iron	..	1	..

Results of tension tests on bars cast-to-size in sand, about ½ inch in diameter and 2 inches long between shoulders, are as follows:

	Specimen No. 1	Specimen No. 5	Specimen No. 13*
Proportional limit, lb. per sq. in.	.....	19,800	.....
Yield point, lb. per sq. in.	24,000	24,000	25,000
Tensile strength, lb. per sq. in.	70,000	77,000	71,000
Elongation in 2 in., per cent	20	24	21
Reduction of area, per cent	20	25	.....

*From eighth report, British Institute Mechanical Engineers.

Aluminum, 92 Per Cent and Copper, 8 Per Cent

Data from J. L. Jones

Following are physical properties of the alloy of aluminum and copper as determined in three laboratories:

	Westhouse Elec. & Mfg. Co.	U. S. bureau of mines	Lumen Bearing Co.
Tensile strength, lb. per sq. in.:			
Chilled	.....	.....	20,000–24,000
Sand	19,800	.....	16,000–20,000
Poured hot	.....	15,500	.....
Poured cold	.....	20,000	.....
At 500 ° Fahr.	.....	19,300	.....
Yield point, lb. per sq. in.	15,400	.....	.....
Elastic limit, lb. per sq. in.	5,000	13,000	.....
Elongation in 2 in., per cent	0.8	1.5	1–2
Reduction of area, per cent	4.9	.....	.....
Transverse strgth, lb. per sq. in.	.....	290	.....
Transverse deflection, in.	.....	0.22	.....
Impact resistance, blows:			
4.7-lb. hammer.	300	.....	.....
2.3-lb. hammer	7,000	.....	.....
Brinell hardness.	50	.....	.....
Specific gravity.	2.83	2.84	2.8
Wgt. per cu. in., lb.	0.102	.....	0.10
Shrinkage, in.	0.175*	.....	3/16†
Coefficient of expansion per deg. Cent., 0 to 100 degrees	.....0.0000240	.....	.....
Resistance, microhms p'r cu. in.	1.609	.....	.....
Conductivity, per cent	39	.....	.....
Mach. qualities.	.....	§	.....
Hot shortness:			
At 1300° Fahr.	.....	235‡	.....
At 1500° Fahr.	.....	90‡	.....

*In 12 by 1 by 1-in. bar.
†Inches per foot.
‡Norton, Transactions, American Institute Metals, Vol. 8, p. 124 (1914).
§Soft and gummy.

Booth-Hall Co. Will Build Electric Furnaces

The Booth-Hall Co., 565 West Washington boulevard, Chicago, has been organized to engage in the building of electric furnaces. C. H. Booth has been elected president and general manager; Julius R. Hall will be vice president; F. J. Sheldon, secretary; and W. D. Walker, sales manager. W. K. Booth has been appointed metallurgist. All of the members of this firm formerly were affiliated with the Snyder Electric Furnace Co. Patents have been applied for on an electric furnace to be designed in three different types to meet the metallurgical conditions of the individual customer and to operate one, two or three-phase. A contract already has been closed, for a 4-ton, 2-phase furnace which is to be the first unit to be installed by a newly organized electric steel company.

B. W. Pharis has been appointed foundry superintendent of the American Blower Co., Detroit.

The Early Use of Permanent Molds for Castings

How the Employment of Ferromanganese, Ferrosilicon, Chills and Permanent Iron Molds Affects the Properties of Castings

By Alexander E Outerbridge Jr

AFTER almost a lifetime spent in the study and daily practical application of investigations in metallurgy on a somewhat large scale, more particularly in cast iron in industrial works, sometimes I feel that I know less about the subject today than I thought I did nearly 40 years ago. This is not surprising, however, for I believe it is the universal experience of investigators that the more they delve into Nature's mysteries the more they find to discover; thus, relatively, the more one studies the less one feels that he knows.

The history of the study of astronomy affords, for example, a striking illustration of this. Long before Galileo pointed the first telescope at the heavens, in 1609, the old monks, with infinite pains, had mapped out the firmament and recorded the positions of all the stars then visible to the eye of man and they naturally thought that their charts were complete. But the moment the new and more powerful eye of the telescope was pointed at the blue vault, hundreds of thousands of starry worlds came into view whose existence had never before been suspected, revealing glowing stars so far distant that the light from them must have started on its long journey centuries before the Christian era. So it is with more mundane affairs, such as the study of the composition and physical properties of metals and alloys. Chemistry has told us pretty well the elements and proportions of the components of complex alloys like cast iron, but after all, that is a very dim light to guide us and it only reveals a few of the most conspicuous properties, leaving many others yet to be discovered by those who come after us.

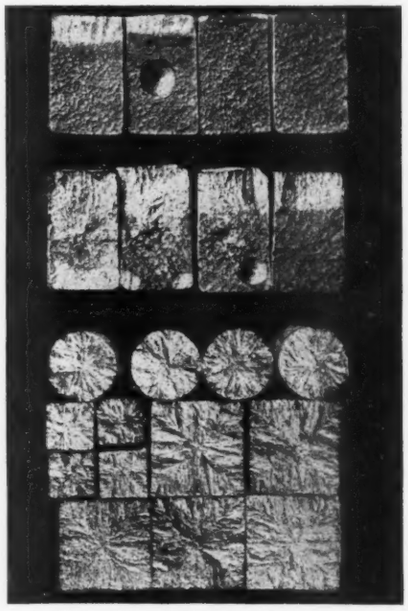


FIG. 1—FRACTURES OF CAST IRON TEST BARS

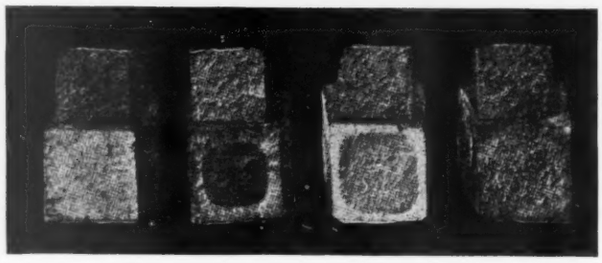


FIG. 2—SOFTENING EFFECTS OF FERROSILICON ADDED TO A LADLE OF MOLTEN METAL

In comparatively recent years the microscope has supplemented chemical analysis and has given us much valuable information regarding the effect of heat treatment upon the structure of metals, especially iron and steel. The spectroscope also has shown us the signatures of all metals, written in fine lines of colored lights that cannot be imitated or disguised.

The specific gravity of alloys and the remarkable changes in density that may be effected by heat, as in the case of the extraordinary growth of gray cast iron when subjected to repeated heating and cooling* or the equally remarkable change in density caused by sudden cooling from the liquid to the solid state, as shown in the tread or periphery of a chilled cast iron car wheel, are subjects of great interest for study. These are but a few of the aids to the study of metals now available and a vast unexplored field yet remains for the future investigator.

The difference between wrought iron, steel and cast iron, commonly is attributed mainly to the proportion of carbon, silicon, sulphur, phosphorus and manganese, together with a few other elements composing these alloys, and the analytical chemist has no difficulty in determining the relative proportions of these elements with sufficient accuracy; but beyond this lies a region of which he knows nothing. He does tell us, it is true, that carbon exists in iron in two different forms, combined and graphitic, but how many other forms of carbon may there be united with these other elements? We already know of three totally different forms of pure carbon, as follows: A soft, intensely black substance called lamp black which the chemist tells us is 100 per cent carbon; an intensely hard, transparent crystal, the diamond, also 100 per cent carbon and pure plumbago or graphite, an unctuous material, quite different from the other forms, also 100 per cent carbon. There is absolutely no chemical difference between them.

In like manner it is known that pure silicon exists in three distinct forms or amorphous conditions. So it is with some and probably all of the other elements combined with iron.

The chemist or physicist is not yet born who, by any known methods of investigation, can state positively or even guess at the various possible forms or combinations of the elements composing these alloys and, therefore, it is not surprising that frequently the analyses of two specimens of iron, steel or other metals will be nearly alike when the physical properties are different. These are a few of the problems that I have been

Presented at the June meeting of the Philadelphia Foundrymen's association. The author is metallurgist of Wm. Sellers & Co., Inc., Philadelphia.

*Two bars of gray cast iron were displayed by Mr. Outerbridge, that were cast in one mold from one ladle and were both originally the same size, namely, 14⅛ x 1 x 1 inches. The specific gravity of the metal was 7.21, making 450 pounds to the cubic foot. One bar had been permanently expanded or caused to grow while in the solid form to 16¼ x 1⅛ x 1⅛ inches, making an increase of 40.97 per cent. The specific gravity of the expanded bar is 5.54, making 350 pounds to the cubic foot. Other bars of gray cast iron have been caused to increase in cubical dimensions over 50 per cent by repeated heating and cooling, still retaining their metallic qualities.

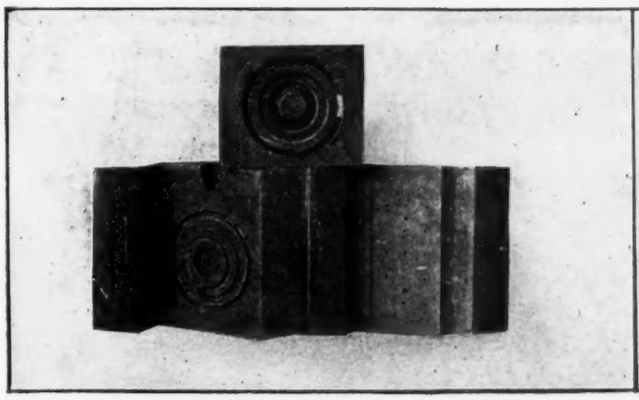


FIG. 3—AN IRON MOLD MADE IN 1903 AND THE CASTING IT PRODUCED

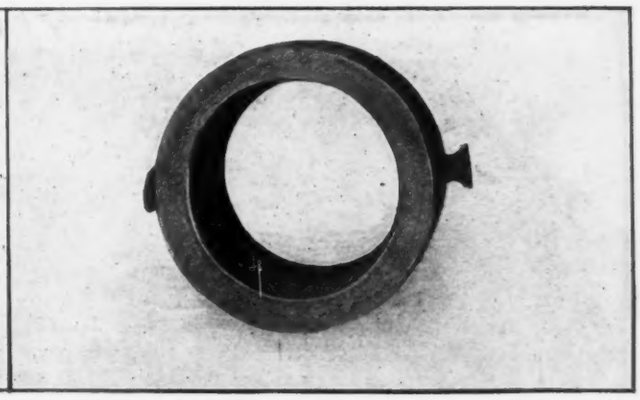


FIG. 4—IRON MOLD FOR A BUSHING OF A 42-INCH CAR WHEEL LATHE

studying for a period of nearly 40 years.

A number of cast iron test pieces made to illustrate an address which I delivered before the Franklin Institute in 1888 on "The Relation Between the Physical Properties and Chemical Constituents of Pig Iron" are shown in Fig. 1. These test pieces were cast from eight different melts of iron. The two upper rows were poured in green sand molds having an iron chill block on one face.

The test bar at the right hand upper corner shows merely a skin chill on the part cast against the iron block; the next bar displays a little more chill and the other bars show increasing proportion of white iron on the upper faces and two show white iron on the lower faces also. Underneath the eight test pieces cast in sand, are nine square and four round test pieces, all *white iron,* showing very clearly that the crystals are always formed at right angles to the surface of the mold. These test pieces were cast in *iron molds* from the same ladles of iron as the other bars and it will be noted that all are equally white, notwithstanding the fact that the bars cast in sand with an iron chill block on one face vary enormously in depth of chill.

These iron molds may be called *chill magnifiers.* I have used similar chill cups daily for detecting chilling properties in soft foundry irons for over 30 years, and they have proved to be of the greatest value in detecting chill that would not otherwise be suspected in such iron mixtures.

The main difference in composition of the eight melts of iron shown in Fig. 1 was found to be in the relative proportions of silicon. The test piece showing a mere trace of chill has over 1.5 per cent silicon; the one showing the most chill has about 0.60 per cent silicon and the other test pieces contain silicon ranging between these extremes.

Charcoal Irons Make Car Wheels Possible

The manufacture of chilled cast iron car wheels, a purely American invention, to which the development of railways in this country may be said to owe their rapid progress in the early days and to which they are still largely indebted for freight traffic, was rendered possible by the practical application of the chilling property found in our cold blast charcoal irons, and its continued success today is dependent largely upon the skill of the chemist to simulate those natural qualities by other means, long after cold blast charcoal iron has gone out of existence.

My first investigation of this peculiar property of cold blast charcoal iron (and of some grades of anthracite and coke iron) dates back to 1876, when a fine exhibit of chilled cast iron car wheels at the Centennial exhibition first attracted my attention. One of the wheels was broken to show the fracture; the plate and brackets were dark gray, while the tread of the wheel was as white as silver. I learned that the white iron tread was formed by the sudden cooling of the metal cast against a heavy iron chill ring and that while the plate and hub of the wheel were quite soft, the tread was hard as steel.

At that time I was making some specific gravity determinations of various metals in the assay laboratory of the mint, where I was an assistant, and samples of the white iron forming the tread of a wheel and of the dark gray iron forming the body were furnished to me for examination. I was astonished to find that the white metal weighed about 60 pounds to the cubic foot more than the gray iron portion of the same casting. This served to explain the abnormal cooling strains in a chilled casting of this character, necessitating prolonged annealing, or very slow cooling, to enable the molecules to adjust themselves gradually, relieving the strain.

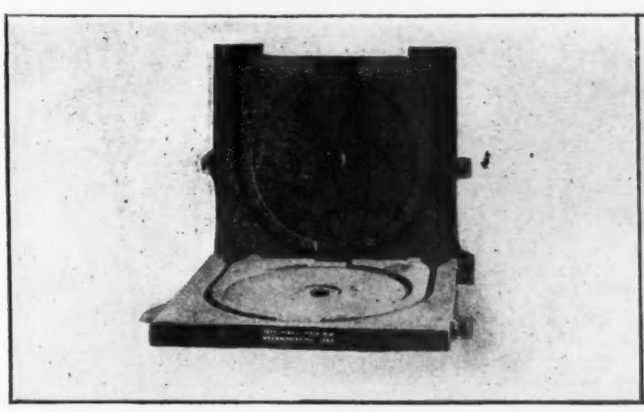


FIG. 5—AN IRON MOLD FOR A FRICTION DISC

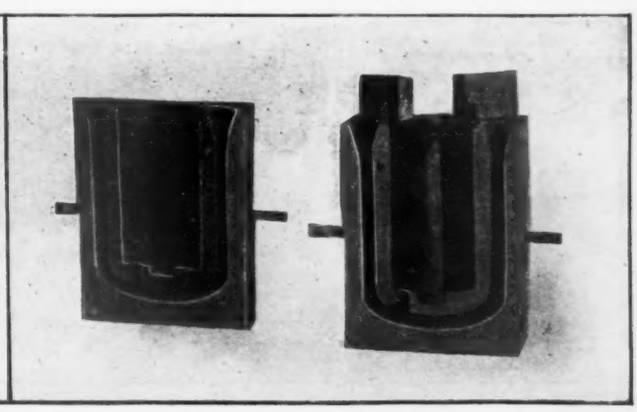


FIG. 6—IRON MOLD AND CORE FOR A SPIRAL PINION

FIG. 7—IRON MOLD WITH A COLLAPSIBLE CENTRAL PORTION

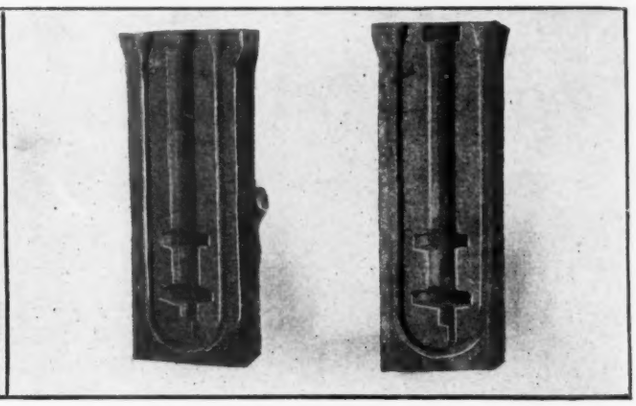


FIG. 8—IRON MOLD FOR SPINDLE OF A HORIZONTAL DRILL

These investigations led to others, and for a period of eight years I was daily engaged in the study of the metallurgy of chilled cast iron car wheels and their manufacture. It was customary to cast each day in the car-wheel works where I was engaged as metallurgist a large variety of chilled car wheels ranging from full size, double-plate passenger and freight wheels, 33 inches diameter, street car wheels (usually of spoke pattern), down to small and light mine car wheels.

It was not possible to pour all of these from one mixture of iron, since the metal suitable for the heavy wheels was too high chilling for the smaller wheels. This necessitated melting soft iron every day in a separate cupola to mix in varying proportions with the regular iron in separate ladles.

To overcome this expense, if possible, by altering the character of the iron in individual ladles, after delivery from the cupola, a great many experiments were made (1880-4) with aluminum costing $8 per pound, spiegeleisen and 80 per cent ferromanganese, granulated or powdered, added in small quantity to the metal in the ladles.

The effects produced by aluminum and spiegeleisen were in the right direction though they were not sufficiently marked to be valuable, but it was then found that when powdered 80 per cent ferromanganese was added in the proportion of one pound to 600 pounds of iron, a most remarkable change was immediately produced in the character of the molten iron in the ladle. The first publication of these experiments was made in the address already alluded to, printed in the Journal of the Franklin Institute, March, 1888, and was as follows:

A remarkable effect is produced upon the character of hard iron (i. e., high chilling iron) by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered 80 per cent ferromanganese, say one pound in 600 pounds of iron. The result of several hundred carefully conducted experiments which I have made, enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent, the shrinkage is decreased from 20 to 30 per cent and the depth of the chill is decreased about 25 per cent, while one-half of the combined carbon is changed into free carbon.

Prior to this time, manganese always had been regarded as a hardening element in cast iron and the surprising claim that when added in a ladle of high chilling car wheel iron it had an opposite effect at first met with incredulity, but in course of time its use became almost universal, and I believe it still is used very largely in the manufacture of chilled cast iron car wheels. No application for patent rights was made for this process.

Ferromanganese, when added in powdered form to a ladle of molten car wheel iron acts as a deoxidizing and desulphurizing flux by reason of the strong affinity of manganese for oxygen and sulphur, but it is only efficacious when added to iron that is comparatively low in silicon, less than 1 per cent, and high in combined carbon.

It is absolutely useless, if not positively harmful, when added to foundry mixtures carrying over 1 per cent silicon and but little combined carbon, yet I know that 80 per cent ferromanganese has been sold to foundrymen for the treatment of their foundry iron mixtures during the time when the alloy could be bought for a few cents a pound. Its present price is prohibitive, except for special purposes.

The use of ferromanganese as a flux in ladles in car wheel manufacture is of enormous value to that indus-

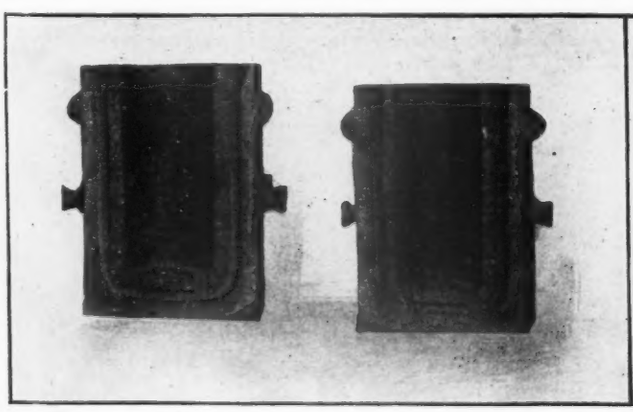


FIG. 9—IRON MOLD FOR A SPIRAL PINION OF A 174-INCH PLANING MACHINE

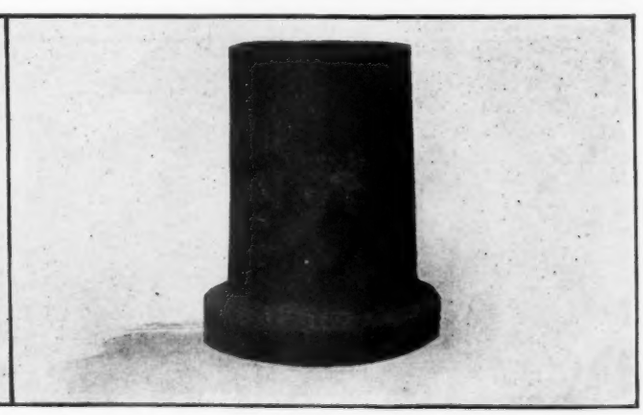


FIG. 10—AN IRON MOLD FOR A FLANGED BUSHING

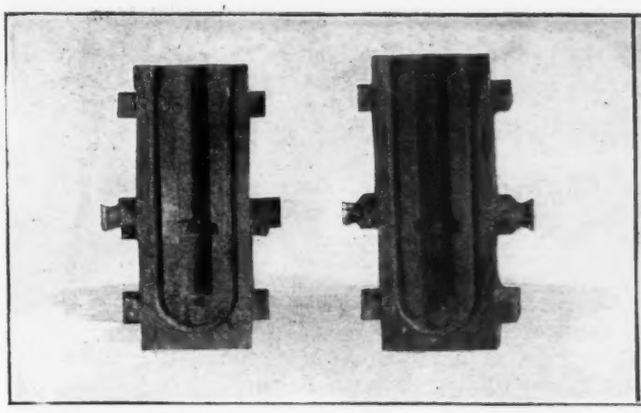


FIG. 11—AN IRON MOLD FOR A SPINDLE OF A RADIAL DRILL

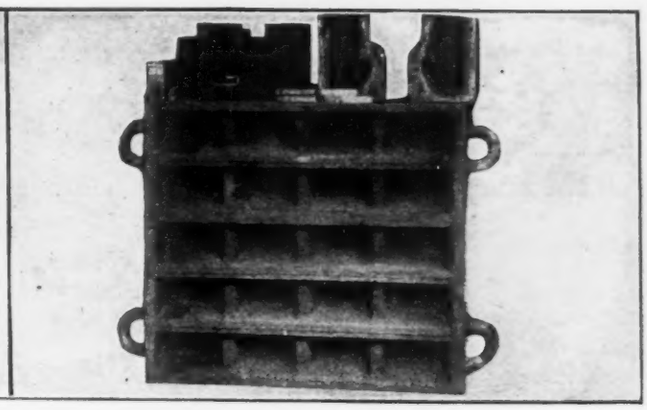


FIG. 12—AN IRON MOLD FOR OVER-PIG

try; its abuse through ignorance or failure to understand its proper functions must have led to disappointment when added as a flux in ladles of foundry iron by those who do not understand or appreciate the radical difference between car wheel iron and foundry iron, whether soft or hard.

While the manufacture of chilled cast iron car wheels requires very accurate control of the chilling property of the metal, it is of far more uniform character than the iron needed for the great variety of castings, ranging from a few pounds up to perhaps 30 tons or over, that must be melted often in one day in the large machine tool works with which I am connected as metallurgist. It is customary, therefore, to group all the small work needing soft, ductile iron so that it will be cast near the beginning of the run of iron from the cupola; this is followed by a medium grade of iron for miscellaneous castings capable of being machined readily, but not too soft to give good wearing service; this again is followed by strong iron mixtures intended for large and heavy work requiring metal of high tensile and transverse strength.

The importance of having some simple, cheap and reliable method of changing the physical properties of molten iron after it has been tapped from the cupola has been regarded as advantageous ever since the value of the method of modifying the chilling property of car wheel iron in individual ladles, by treatment with powdered ferromanganese, became well known. This led to the improper use of ferromanganese in ladles of foundry iron through ignorance of its proper functions.

As long ago as 1880 I made efforts in this direction with alloys of iron and silicon, but at that time the richest alloy obtainable contained less than 20 per cent silicon.

Use of Ferrosilicon

In later years 50 per cent ferrosilicon was produced in electric furnaces for use in steelmaking and these tests were then renewed with the results that have been already published, showing that the addition of a small quantity of the powdered 50 per cent ferrosilicon alloy in a ladle of molten foundry iron produces a remarkable effect upon it, by *softening* and at the same time *strengthening* the iron. This is quite an opposite effect to that produced by increasing silicon in the cupola, which always tends to weaken iron. The accompanying table shows the results of a few tests of this kind made in 1905 with ordinary foundry irons.

The effect of adding four ounces of powdered, 50 per cent ferro-silicon in a hand ladle holding about 25 pounds of molten iron, and of adding one pound to 200 pounds of iron in a ladle, upon the strength and deflection, as compared with the same iron untreated, is clearly indicated in this table.

The success of these initial tests led to more extended investigations. Fig. 2 shows the remarkable effect in reducing chill in foundry iron by adding thereto powdered 50 per cent ferrosilicon in different proportions in the ladle, ranging from 0.30 to 0.80 per cent of silicon. In Fig. 2, No. 1 shows the fracture of two test bars cast from a ladle of untreated iron. The upper piece was cast in green sand, 1 x 1 x 15 inches, and was an ordinary transverse test bar. The lower piece was cast in a heavy iron cup to cool the metal rapidly. The upper test piece is gray and is easy to drill. The lower one is perfectly white and cannot be drilled with an ordinary steel drill. No. 2 shows the fracture of two similar test bars poured from the same iron after the

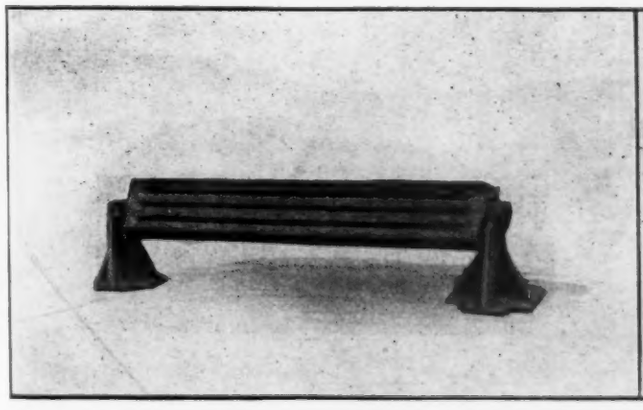


FIG. 13—IRON MOLD FOR CASTING LONG CORE RODS

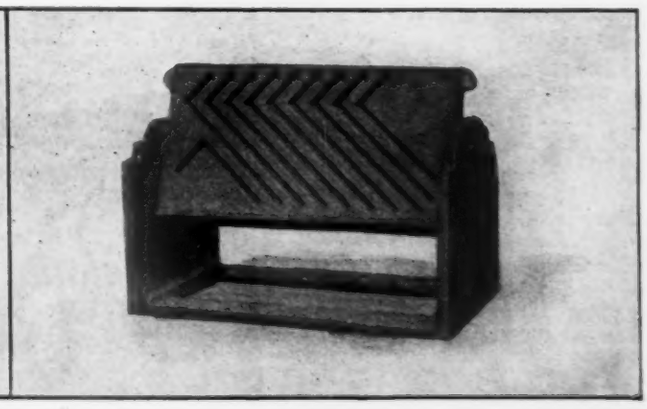


FIG. 14—CAST IRON MOLD FOR CASTING GAGGERS

Results of Tests Following the use of Ferrosilicon in the Ladle

Date	Amount of silicon used	Breaking strains, pounds	Deflection, inches	Resilience	Shrinkage inches	Per cent gain—Breaking strain, per cent	Per cent gain—Deflection, per cent	Per cent gain—Resilience, per cent
Oct. 10, 1905	¼-pound in	2205	0.120	45.30	0.192			
	hand ladle	2155	0.112	40.09	0.191			
	Gain	110	0.008	5.21	.....	5.10	7.14	13.00
Oct. 11, 1905	¼-pound in	2215	0.137	50.51	0.182			
	hand ladle	2165	0.124	44.60	0.185			
	Gain	50	0.013	5.91	.....	2.30	10.40	13.20
Oct. 14, 1905	¼-pound in	2600	0.152	65.79	0.196			
	hand ladle	2055	0.116	39.18	0.188			
	Gain	545	0.086	26.61	.....	26.50	31.00	67.00
Oct. 15, 1905	¼-pound in	2330	0.143	55.45	0.183			
	hand ladle	1893	0.110	34.00	0.183			
	Gain	437	0.033	20.85	.....	23.8	30.00	60.2
Oct. 16, 1905	¼-pound in	2210	0.124	45.54	0.183			
	hand ladle	2120	0.112	39.44	0.185			
	Gain	90	0.012	6.10	.....	4.20	10.70	15.40
Nov. 13, 1905	1 pound in a	2370	0.139	54.76	0.186			
	200-pound	2050	0.118	40.19	0.184			
	ladle Gain	320	0.021	14.57	.....	15.60	17.80	36.20
Nov. 21, 1905,	1 pound in a	2178	0.128	46.34	0.188			
	200-pound	2000	0.119	39.60	0.182			
	ladle Gain	178	0.009	6.74	.....	8.90	7.50	17.00

addition of 0.3 per cent of silicon in the form of 50 per cent ferrosilicon added in the ladle. Note the marked reduction in depth of chill in the sample cast in the iron cup. No. 3 shows the fracture of two similar test pieces from the same iron after adding 0.5 per cent silicon in the ladle. The chill is still further reduced. No. 4 shows the fracture of two similar bars from the same iron after adding 0.8 per cent silicon in the same manner. The chill in the sample cast in the iron cup is almost entirely absent.

The samples cast in sand are all gray, but there is an appreciable difference in the fracture, the treated metal showing softer iron than the untreated sample.

Metal Selected for Test

The metal selected for this particular test was comparatively low in silicon, consequently having comparatively high chilling property, but this fact would never be suspected from an examination of the fracture of the test sample cast in sand. Very few practical founders are aware of the large variation in chilling property of their iron, sometimes of presumably similar grades, melted on different days, or even of the wide variations which may occur in different portions of one heat.

In "The Metallurgy of Steel", by Henry M. Howe, the author refers to silicon as follows:

Iron absorbs silicon greedily, uniting with it in all proportions at least up to 30 per cent and apparently the more readily the higher the temperature, absorbing it even at a red heat when embedded in sand and charcoal. It diminishes the power of iron to combine with carbon....thus favoring the formation of graphite during slow cooling. It increases the fusibility and fluidity of iron; it lessens the formation of blow holes; by reducing iron oxide it apparently removes one cause of red shortness; it hinders at high temperatures the oxidation of iron and probably of the elements combined with it.

Here we have, I think, a practical solution of one great difficulty that heretofore has militated against the successful use of permanent iron molds for making castings that must be machined.

Skin Chill

A mere skin chill, not thicker than a piece of tissue paper, makes the surface of a casting too hard to machine, but by this simple process of adding a small quantity of 50 per cent ferrosilicon in the ladle, the foundry foreman can eliminate the last trace of chill from his metal before pouring it into an iron mold.

For years more or less encouraging efforts have been made and described in technical journals of methods for making castings in permanent iron molds. The most ambitious one, perhaps, was the pipe casting process of Edgar Allen Custer at Tacony, Pa., a few years ago, for which he obtained several patents. Mr. Custer ingeniously overcame the trouble from skin chill on his castings by turning them out of the molds before the molecules had taken a final set and the intense heat in the body of the castings helped to anneal-out any skin chill that might have formed. Mr. Custer failed, unfortunately, to take into due consideration the fact that gray cast iron, of which his molds were made, grows or increases in cubical dimensions when repeatedly heated above a certain point and then cooled.

Early Use of Permanent Molds

Since 1888, machinable castings have been made in the foundry of William Sellers & Co., Inc., in permanent iron molds and still are being so made. Through the courtesy of the president of that company I am now permitted to display illustrations of the original iron molds, still in use, together with some machinable castings that were made in them years ago. Also large and small molds of more recent manufacture. In fact, more than 100 permanent iron molds, ranging in weight from a few pounds up to 7000 pounds each, are in use in this foundry.

The main object of casting in iron molds is to secure machinable castings of exceedingly fine grain, free from dirt, sponginess or other defects, while at the same time having marked increase in strength.

The question of relative cost of castings made in permanent iron molds, eliminating the molder entirely, as compared with similar castings made in green sand, or in baked sand molds, depends upon the number of machinable castings required to be made from one pattern as well as upon other conditions.

An all-iron mold made in 1903 for a saddle for 36-inch planing machine,

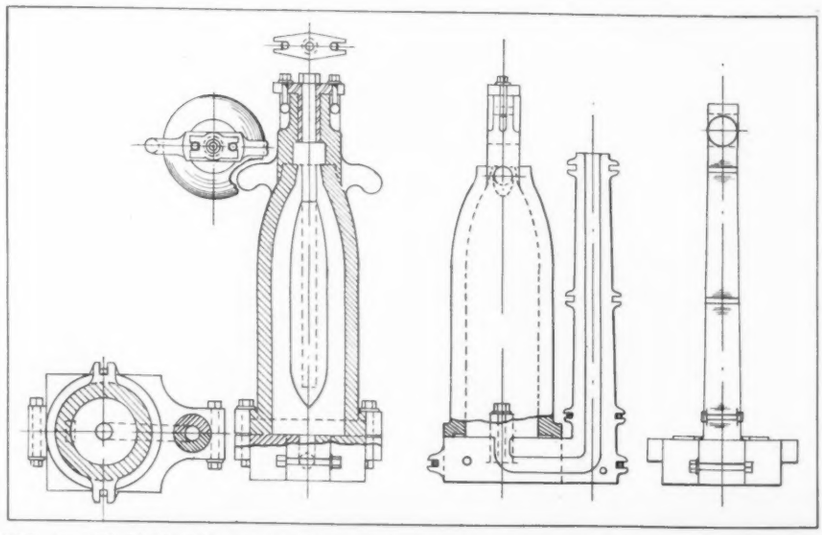


FIG. 15—AN IRON MOLD 30 INCHES LONG, FOR CASTING 10-INCH PROJECTILES

also one of the gray iron machinable castings, absolutely free from any skin chill, made in this mold, are illustrated in Fig. 3.

This was a difficult casting to obtain free from surface defects on one or the other face, or from draw holes, when made in sand, but when cast in this iron mold, they were perfect, and all the saddles subsequently produced, until a change was made in design, were cast in this iron mold.

This mold was made 15 years after my first iron mold was constructed and used in the foundry of William Sellers & Co., and 23 years after the first iron mold was made by me for casting *over-iron* in another foundry, and thereby hangs an amusing tale.

An Amusing Incident

In 1880 I suggested to the foreman of the car wheel foundry of A. Whitney & Sons, Philadelphia, with which I had become connected as metallurgist, the idea of casting all the *over-iron* in iron molds instead of in open sand molds, thus giving more room on the foundry floor and thereby avoiding the expense of making-up a sand pig bed daily.

The foreman exclaimed in alarm, "Why, it will be all *white* iron and when we remelt it with the wheel mixture the next day the wheels will all be too hard. We do use a little white iron sometimes to bring up the chill when the mixture is running down in chill, but this plan would spoil all our calculations."

Nothing but an actual demonstration would convince the man of his error. Iron pig molds were then ordered to be made and a ton of regular wheel iron cast therein. This iron, of course, was white. The next day the ton of white iron was remelted in a small cupola without any admixture and cast into test bars, chill test pieces and two test wheels. On the following day, when all of these were broken, instead of being white iron, as the foreman had predicted, there was no appreciable difference between the castings made from iron that had been chilled white in the iron molds and similar castings made from the same iron cast in sand molds. The result was that no sand pig bed was ever made in that foundry as long as the works continued in existence.

When I became connected with William Sellers & Co., Inc., in March, 1888, I found the same conditions and immediately substituted iron pig molds which have been used daily ever since that time.

These iron molds, for over-iron, anticipated by many years the machine-cast pig iron process now so generally used, and naturally led to the next step, namely, making permanent iron molds for castings, as soon as it was found practicable to prevent iron poured in them from being too hard to machine readily.

Anticipating the question, "How do you prevent these molds from warping or growing so as to become useless"? I will say there are two distinct methods. The simplest method and the one we adopt is to make but one casting from one melt in one iron mold. In this way the mold never gets red hot so that it does not grow. The second method is to use low silicon iron for the molds, as metal of that character grows far less when repeatedly heated and cooled above a cherry red than soft foundry iron. Finally, castings made of white iron do not expand permanently when heated and cool sufficiently to overcome the original shrinkage of the metal, so that when practicable, permanent iron molds may be made of white iron. The accompanying illustrations show iron molds that have been made and used in the Sellers foundry for making machinable castings.

An iron mold for a bushing of a 42-inch car wheel lathe is shown in Fig. 4. This bushing is 19 inches in diameter, 13½ inches deep and only 1 inch thick. The mold is 6½ inches thick and it has a collapsible iron core. The metal must be absolutely free from chill as the thin casting is turned inside and outside.

Large Disc Cast in Iron Molds

Fig. 5 is an iron mold for friction discs for dynamometer for the Pennsylvania railroad; these castings are 42 inches in diameter, are cast 1½ inches thick and are finished all over, ⅞-inch thick. The pull on the draw bar of the locomotive on this machine was originally 80,000 pounds, and was afterwards increased to 100,000 pounds. It was essential that these cast iron discs should be fine-grained and free from the slightest defects. After failing to procure satisfactory castings in sand molds they were cast without flaws in this iron mold. The casting was poured from the bottom.

The iron mold and core for a spiral pinion for a 36-inch planing machine are illustrated in Fig. 6. This has five teeth, 2 inches deep, cut from the solid metal. Semisteel was cast in this mold, free from chill. It was poured from the bottom.

Fig. 7 shows an iron mold with a collapsible central portion. This is the mold for a gear ring for a 42-inch car wheel lathe. Teeth are cut in the ring which is cast solid. The mold is cast open and semisteel is used. Over 100 rings have been cast in this mold. The blank ring is 5 feet in diameter, 8 inches deep and 6 inches thick.

An iron mold for the spindle for a horizontal drill is shown in Fig. 8. This mold is 5 feet long, 21½ inches wide and 18 inches thick. The core is 2½ inches in diameter and the metal of the spindle is 1¼ inches thick. The casting is poured from the bottom.

Fig. 9 is an iron mold, 42 inches long and 28 inches wide, for a spiral pinion of a 174-inch planing machine.

Castings in Permanent Molds

Fig. 10 is an iron mold for a flanged bushing for a 72-inch boring mill. The bushing is 15½ inches in diameter and the metal thickness is ¾ inch.

Fig. 11 is an iron mold for a spindle of a radial drill. The mold is 40 inches long, 16 inches wide and 12½ inches thick. The spindle is 4½ inches in diameter, has a 2-inch core and the metal is 1¼ inches thick. The mold is poured from the bottom.

An iron mold for *over-pig* is shown in Fig. 12. The molds were first made in 1880 and this one has been in daily use for many years. On top of the mold are two iron molds for lifting nuts for the crossheads of large boring mills. These castings must be made of very strong, fine-grained iron. Also on top of the molds are two test bars, originally of the same size, 14 13/16 x 1 x 1 inches cast in the same mold from one ladle of iron. One bar has been caused to *grow* or increase in size to 16½ x 1⅛ x 1⅛ inches, equivalent to 40.98 per cent enlargement.

Fig. 13 is an iron mold for casting long core rods. This has been in use since about 1890. It is so designed that it never warps. Many thousands have been cast in this mold.

A permanent mold of waffle iron design, mounted on trunnions for casting gaggers, is shown in Fig. 14. It has been in use since about 1890. It is so designed that it never warps. Many thousands of gaggers have been cast in this mold.

Fig. 15 is a drawing for an all-iron mold for casting 10-inch projectiles, 30 inches long. The mold was made in 1891. A number of gray iron castings were made in this mold and machined all over. They resembled steel projectiles in appearance. These projectiles were sent to Washington and pronounced the finest cast iron projectiles ever made, but about that time the authorities decided that steel alone should be used; hence, only 14 of these castings were made in this mold.

Electric Furnace as a Copper-Melting Medium

Some of the Advantages and Disadvantages of the Granular-Resistance Type of Electric Furnace in Melting Copper and Its Alloys

By Charles Vickers

THE serene faith of those who contemplate the millenium finds a counterpart in the minds of some brass founders when they think of the electric furnace in connection with the industry to which they have devoted their lives. They realize keenly the defects of existing methods of melting copper and its alloys, and look forward to the day when they will be able to throw in a switch and have their metals melted without contamination by the products of combustion. Therefore, any discussion of the performances of electric furnaces in melting copper alloys is interesting in showing what is being done and in pointing out that the work is going forward, even if not entirely crowned with success.

The subject of this article is a granular-resistance furnace designed and built by the Fitzgerald Laboratories, Inc., Niagara Falls, N. Y., for melting copper and its alloys without departing greatly from the traditions of brass foundry practice. The furnace was designed for the use of crucibles to meet conditions where every heat would be different from its predecessor, and it was imperative that one heat should not contaminate another.

For large metallurgical operations connected with nonferrous alloys it is beginning to be realized that the day of the crucible is passing slowly and, therefore, the present trend in furnace design, electric or otherwise, is to eliminate the crucible by melting the metal in bulk. However, this is not as easy as it might appear, and as the matter is of considerable importance we will digress a little to point out the reason therefor.

A crucible is a wonderful creation; it withstands high temperatures, great pressures and the action of molten metals extremely well. Therefore, it forms an efficient melting vessel for a large majority of the alloys used in brassfounding. This is not the case with a furnace lining which usually is made of siliceous materials, such as bricks, carborundum, etc., and which form chemical compounds with the constituents of some alloys to their great detriment. This is a point that has not received much consideration heretofore, but it is so important that when it comes to be generally recognized that the less silicon contained in the lining of a brass melting furnace the better operating results, a tremendous forward stride will have been made in the application of open-flame furnaces to the melting of copper alloys. In the present state of the art, a noncrucible furnace may be a wonderful success for melting copper-zinc alloys and equally as great a failure in melting phosphor bronze, while no one having only an elementary knowledge of chemistry would ever think of applying it to the melting of aluminum bronze. Therefore, the usefulness of the noncrucible furnace, whether electric, gas or oil-fired, is limited because of the chemical constituents of its lining, and in cases where this is not realized and the furnace is used for melting alloys for which it is unsuited, puzzling difficulties are encountered that ultimately force a resumption of the former practice of crucible melting. Before leaving a subject of such interest and importance to both furnace manufacturer and user, it may be well to mention that the problem of a nonsiliceous lining for brass melting furnaces is not hopeless of solution in view of the present resources in refractory materials.

How the Resistance Furnace Operates

A resistance furnace operates on the same general principle as the incandescent lamp. In the latter the light is produced by the filament because it is too small to carry all the electric current that attempts to crowd through it when the switch is turned on. The result is that the filament is overloaded, heat is generated, the filament becomes incandescent and light is emitted. In the resistance furnace the heating element is a continuous conductor the same as the filament in the lamp. Similar to the filament, it is a poor conductor of electricity, and offers resistance to the passage of the electric current, thereby producing heat. Most electric heating devices are constructed on the resistance principle, and in an elementary form many consist of a helix of iron or nickel-chromium alloy wire which, when loosely coiled around an asbestos-covered length of stove pipe fitted to legs, with the coils arranged in such a manner that they do not touch one another, forms a rather crude, but quite efficient electric heating device. Annealing ovens and muffles are constructed on this principle that will develop temperatures approaching 1000 degrees Cent., or 1832 degrees Fahr. These consist of a suitably shaped, hollow, fireclay tile, wound externally with coiled wire the ends of which are attached to devices designed for electrical connection. The fireclay tile, with its winding of wire, is covered with some good heat insulating material and the whole is enclosed in an iron box to make a neat appearing, rectangular oven. When the proper current is passed through the wire around the tile constituting the oven, it becomes red hot and the heat passes through the walls of the tile and the oven becomes heated to a glowing temperature.

Furnaces constructed on this principle will melt the most refractory of the ordinary metals. Of course, iron or nickel-chromium wire cannot be used for the resistance element as it would melt before the charge. In place of the usual resistance alloys, molybdenum wire has been used and in such furnaces the writer has seen pure iron lie liquid for hours. A molybdenum wire wound furnace, however, is too expensive for commercial use, not only on account of the cost of the heating element, but because it must be protected against the destructive action of oxygen. In the lamp the air is exhausted, similar to the filament of an incandescent lamp, but in the furnace this is not practicable; therefore, the air must be displaced by an inert gas, so that in the case of the molybdenum wire wound furnace it is necessary to continually pass hydrogen through the furnace to envelop the heating element in this gas; otherwise, it would burn or oxidize and would be destroyed.

In a granular resistance furnace, the heating element, as its name implies, is formed of some granular substance such as coke and the resistance of the coke can be varied by the closeness with which it is packed, and by mixing with the raw coke other coke that has been partially graphitized.

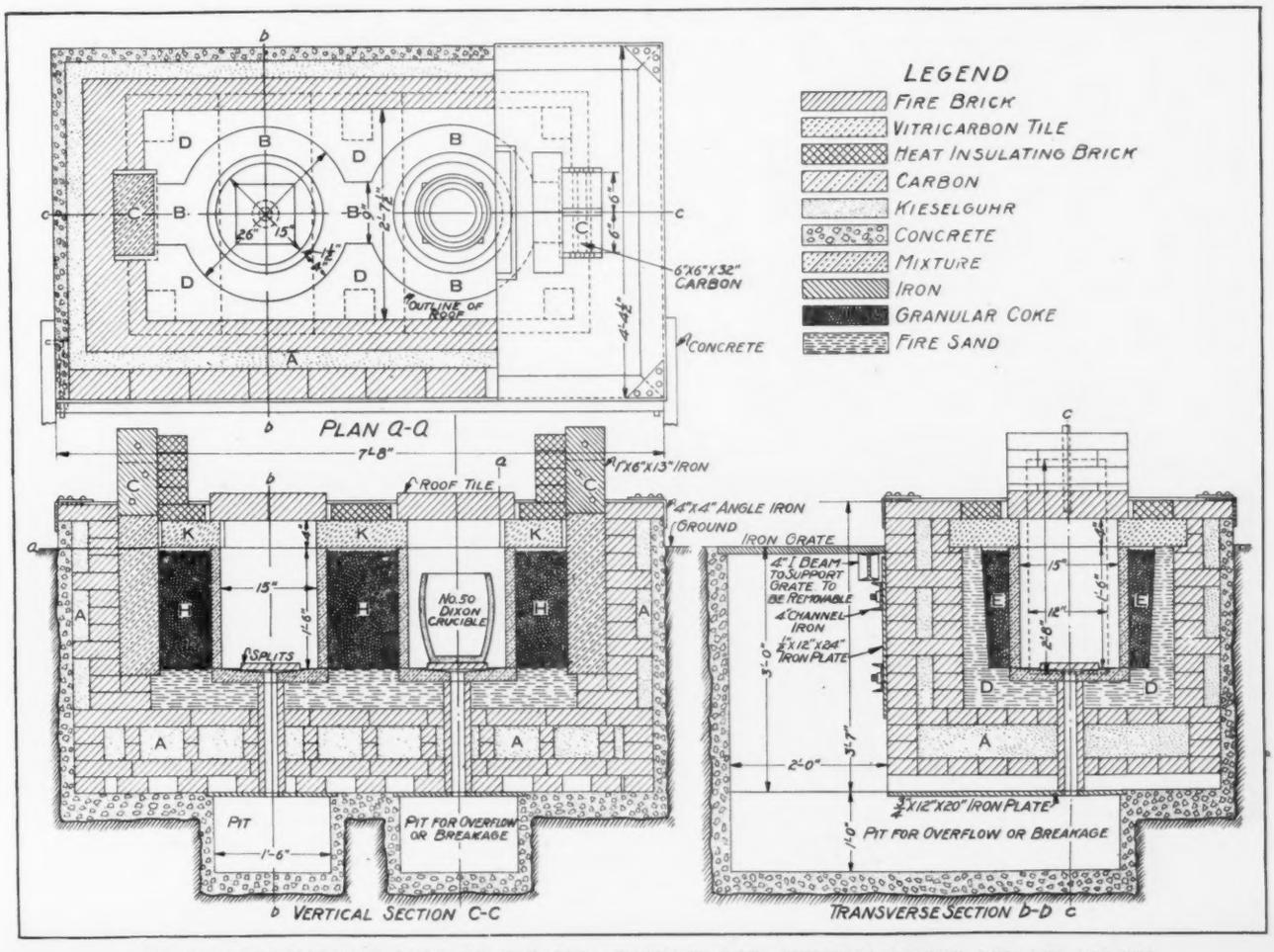
The furnace herewith illustrated was built inside of a rectangular concrete pit in the ground, with a space in front the same as a coke hole. This space, however, was not provided for the removal of ashes, but to give access to the overflow pits directly underneath the melting holes, so that any metal, due to leakage, could be removed therefrom.

The walls of the furnace were built of fire brick and were made double with an air space between each wall. This air space was packed with kieselguhr, as shown at *A*, the object being to conserve the heat as much as possible as a measure of economy. The success with which this end was attained is demonstrated by the fact that after the furnace was shut down the melting holes would remain red hot for 12 hours and would not cool to the shop temperature for two weeks. In this type of electric furnace heat insulation is important, as the source of heat is too costly to permit of loss by radiation. The brickwork formed a rectangular box, the bottom of which was perforated by two openings which communicated with the two overflow pits at the lowest point of the furnace, for draining the metal from the melting holes in the case of crucible breakage.

Results of One Day's Operation of a Granular-Resistance Furnace

Time	Volts	Amperes	Remarks
8:30 a.m.	120	190	
8:45	120	240	
9:00	120	400	
9:15	120	570	Melting holes red
9:32	120	720	
9:41	110	690	
9:44	100	630	
10:00	100	660	
10:12	92	630	
10:30	92	600	
10:40	89	580	Temperature 1200 degrees Cent.
10:42	100	630	
11:00	100	720	
11:05	100	720	A heat of copper charged, 25 lbs.
11:15	100	720	
11:25	100	720	Copper molten.
11:30	100	720	Copper removed and cast.
11:45	100	720	
11:46	90	630	
11:55	90	620	Copper charged, 25 lbs.
12:15 p.m.	90	600	
12:28	90	595	Copper molten and hot enough to pour.
1:00	90	570	Temperature, 1300 degrees, Cent.
1:15	90	590	
1:25	90	610	
1:26	80	520	
2:15	80	480	Charged heat of nickel.
2:40	80	450	
2:50	90	500	
3:35	90	630	
4:00	90	690	Nickel molten, removed and furnace shut-down.

On the bottom of the box a layer of carborundum fire sand several inches deep, was rammed and on top of this the electrodes, *C*, shown in both plan and cross-section, were placed. The electrodes were located at either end of the furnace and consisted of two square pieces of amorphous carbon, 6 x 6 x 32 inches, bolted together. The upper ends of the electrodes were provided with means for the attachment of the terminals through which the electric current was conducted through the furnace. From this point the furnace was constructed like a mold. Hollow, cylindrical wooden patterns, similar in cross-section to *E*, in the transverse section, were bedded centrally on the foundation of fire sand over each drainage hole. The patterns were joined together in the center of the furnace, and were connected at the ends with the electrodes; the patterns thus formed a continuous channel from electrode to electrode, with circular enlargements for the melting holes. The space around the patterns was rammed-up with moist carborundum fire sand to the top of the patterns, thus forming the walls, *D*, shown in the plan, and



GRANULAR-RESISTANCE TYPE OF ELECTRIC FURNACE FOR MELTING COPPER AND ITS ALLOYS

the transverse section through *b-b*.

The next operation was to form the walls of the melting holes. This was accomplished by ramming a bottom of carborundum fire sand, suitably bonded, inside of the wooden ring patterns. On this bottom a solid, cylindrical pattern was centrally located, the diameter of which was made smaller than the diameter of the inside of the ring pattern to provide space between the two, equal to the desired thickness of the walls of the melting hole. This annular space then was rammed solid with a moist refractory mixture of carborundum fire sand bonded with clay and silicate of soda. The patterns were then withdrawn and the walls were patched where necessary and were allowed to air-dry.

When the walls had hardened sufficiently, the resistor consisting of small pieces of coke, graded to pass through a ½-inch screen was placed in the channels left by the removal of the patterns, as shown at *H* in the vertical section. A current of low voltage next was turned on, and the furnace was allowed to dry at a gentle heat. When dry, the top of the furnace was covered by tiles of vitricarbon, to retain the heat and to give the furnace a finished appearance. After the furnace was built many improvements suggested themselves, which would have contributed to its more efficient operation. This was natural, however, in view of the fact that probably this was the first furnace of this type to be installed for operation on a commercial scale.

The melting holes were designed to accommodate No. 50 crucibles, but in practice much smaller pots were employed. The construction of the furnace, with the upright electrodes at the ends, interfered with the safe handling of metal in quantities greater than could be handled easily by one man.

Performance of the Furnace

As to the performance of the furnace, little definte information is available. The accompanying table gives the results of one day's run that may be regarded as typical. An alternating current was used, the consumption of power would be the product of the number of amperes and the number of volts, multiplied by the power factor which was not ascertained. It will be noted that the second heat of copper required eight minutes longer to melt than the first; this was due to the fact that the second heat was held a little longer than the first. In a furnace of this type, metal can be held for hours without deterioration, by closing the drainage pit and tightly covering the furnace. The addition of charcoal around the crucible and on top of the metal insures an atmosphere of carbonic dioxide gas in the furnace which is inert so far as molten copper is concerned. The result is that the copper is melted in the absence of oxygen and sulphur, which is the ideal melting condition for this metal and its alloys. When copper, melted under these conditions, was poured into a chill mold, it appeared to be unchanged so far as could be detected by its behavior, and when poured into sand molds, no swelling of the heads occurred. The resulting castings were porous, but the porosity was very slight and could have been prevented by the addition of a minute quantity of any suitable deoxidizer, with the result that castings of the highest electrical conductivity would have been produced.

Enemies of the Brass Founder

The two great enemies of the brass founder are oxygen and sulphur, both of which are soluble in copper and the alloys of copper, and these exist in the atmospheres of all the ordinary furnaces used for melting these metals. When molten copper contains sulphur, the latter oxidizes to sulphur dioxide (SO_2), which is the gas that causes the metal to spit and become spongy during solidification. In a furnace with a melting chamber constructed as in the granular resistance furnace we are considering, there is neither sulphur nor oxygen, if it is properly managed; consequently, many of the difficulties incident to the production of castings of the nonferrous metals are eliminated, resulting in great economy of both time and money.

It is not the contention that an electric furnace of the granular resistance type is the ideal melting medium for brass foundries. It was employed in this instance because its construction adapted itself readily to the attainment of a melting chamber from which the elements injurious to copper could be most easily excluded during the period of melting. Any other tvpe of furnace can be used, provided it will meet the same conditions. For this purpose the electric furnace has the advantage over the combustion furnace, since heat is not produced by chemical reaction. This is the greatest asset of the electric furnace for melting nonferrous alloys and should be taken advantage of whenever furnaces for this purpose are being designed.

The cost of electric melting may be considerably higher than that of fuel melting, and still the advantage will lie with the electric furnace, provided the peculiarities of copper and its alloys are understood and are taken into consideration when the furnace is designed. This is due to the fact that such furnace would act as a preventative of spongy and otherwise defective castings, which, while they might not be spongy, are scrapped because they fail to meet some physical tests that are imposed. Oxidation is the cause of many defective castings which are part metal and part dirt, and consequently are not strong. The trouble with the spongy casting is due to oxygen and sulphur, or to oxygen and any other element that will oxidize to a gas. Both difficulties are the source of serious losses in brassfounding and are avoided only by the most careful attention to melting details aided by the judicious use of costly additions which act as deoxidizers and desulphurizers and which may be regarded as cures.

The reason why the brassfounder adheres so strongly to crucible melting is because he has found by experience that it gives him the best results. This is due to the fact that he practically is melting in a muffle. The crucible protects the metal, to a very large extent, from the furnace gases, especially if the molten surface is kept covered with a fusible, inert flux, mixed with charcoal. Under these conditions, alloys of excellent physical properties can be produced when the necessary skill is available, but only at the price of eternal vigilance. The necessity for skill and vigilance constitutes the weak point, especially in view of present labor conditions. What is required in brass foundry operations is a fool-proof melting device rather than a cheaper melting medium; therefore, in considering the application of electric power to melting nonferrous metals, ultimate results should count for more than cost of operation.

A Simple Furnace Test

There is a great difference between melting copper, brass and bronze, and iron and steel, and because a furnace may prove eminently successful with the latter metals, is no indication that it will be equally successful with nonferrous metals. The value of an electric furnace for melting brass or bronze can be ascertained by a simple experiment. All that is necessary is to melt, or attempt to melt, a heat of ordinary bronze turnings, minus charcoal or other fluxes. If the atmosphere of the furnace is oxidizing, the turnings will weld together to an infusible mass, and very little liquid metal will be produced. Such a furnace would be far from fool-proof, however. In the granular resistance

FORMULAS FOR THE BRASS FOUNDRYMAN

A Very Stiff, White Nickel Alloy

For all work requiring a stiff, white alloy that will cast fairly well and buff to a finish resembling nickel-plate, the following alloy will be suitable:

	Per Cent.
Copper	65.00
Nickel	32.25
Aluminum	2.75

Melt the copper and the nickel together under charcoal, or use a flux consisting of fluorspar and lime, in a furnace capable of attaining a very high temperature. An oil or gas-fired furnace is preferable to one fired by coke or coal. When the alloy has reached a dazzling, white temperature, add the aluminum carefully and stir with an iron bar coated with alundum cement, thoroughly dried, and cast in dry sand or skin-dried molds faced with fine silica sand bonded with fine fireclay and molasses water. Pour the metal strongly and provide the castings with generous gating facilities.

Nickel Bronze

Nickel bronze is the name generally applied to any alloy of copper and tin containing nickel. The following alloy is a good example of this class of alloys and finds application as a material for making high-grade gears. The alloy follows:

Copper	85 pounds 11 ounces
15 per cent Phosphor-copper	5 ounces
Nickel	3 pounds
Tin	11 pounds

First melt the copper and the nickel together under a cover of charcoal, with a little borax, and when the copper is thoroughly melted and hot, add the phosphor-copper and stir; follow with the tin, stir once more and pour on the warm side.

FORMULAS FOR THE BRASS FOUNDRYMAN

Benedict Nickel

Benedict nickel is most generally used in the form of sheet and tubing by the plumbing trade for lavatory fittings, but at the present there is a considerable demand for this alloy for bullet jackets and many foundrymen are considering the advisability of engaging in its manufacture in the form of bars for rolling. The formula follows:

	Per Cent.
Copper	80.00
Nickel	20.00

In making this alloy, it is advisable to place the nickel in the bottom of the crucible, with the copper on top. About 25 per cent of scrap of the same composition can be used with each charge and may be added with the copper and the nickel. It is good practice to use a *deepener* on top of the crucible to enable all the cold metals comprising the charge to be placed in the furnace at once. This *deepener* is the upper portion of a worn-out crucible and is placed loosely on top of the melting crucible in the capacity of a hopper. In case all the charge cannot be placed in the crucible and deepener, and scrap is used, it is better to reserve some of the copper than the scrap for future addition, as the latter has a higher melting point than the copper.

To protect the metals from oxidation, charcoal is frequently used as a cover, some of which should be added with the cold metals. It is a question, however, whether it is not better to avoid charcoal in connection with copper-nickel alloys, because if carbon is absorbed these alloys do not roll successfully; therefore, some contend that the following flux is more suitable:

	Per Cent.
Unslacked lime	67
Powdered fluorspar	33

Slack the lime to a cream, add the fluorspar, mix thoroughly and dry; use a minimum of one per cent.

Bring the metal to a white heat before removal from the furnace, stir well, and just before pouring, add 0.25 per cent of 30 per cent manganese-copper.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, JULY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

furnace, turnings can be liquified without loss other than that incident to the combustion of organic matter or the evaporation of water that may be mixed with the turnings. If an electric furnace fails on this test it is no better than a combustion furnace so far as ultimate results are concerned; consequently, if it costs more to operate than the fuel furnace, the latter should be given the preference, not only on account of its lower cost of operation, but because its advantages and disadvantages are a known quantity.

In the operation of the granular resistance furnace it was found that there was no comparison possible between the quality of the metal produced by this furnace and that of metal produced in a combustion furnace. Therefore, the results of experiments on metals taken from such a furnace were misleading as quite different values would be obtained from the combustion furnaces.

As previously stated, when copper was melted, very little oxidation occurred and the slight amount of porosity probably was due to the oxidation of the metal in being transferred to the molds and while being poured into them. The copper was not treated with deoxidizers.

The great advantage of such a furnace is that it permits nonferrous alloys to be melted in a neutral atmosphere, thereby eliminating a long list of difficulties. Its other advantages, such as freedom from ashes, are shared in common with oil and gas-fired furnaces. The metal losses possibly may be less than in the combustion furnaces.

The disadvantages of the granular resistance furnace are well known to all who have had experience with such a furnace and are largely connected with the heating medium which develops hot spots; also, the resistance steadily increases so that each time the furnace is started up cold the voltage must be boosted or the furnace requires longer to heat, so that eventually, always using the same voltage to start with, a time would arrive when the furnace would not attain a melting temperature before the day's work was over. To counteract this, it is necessary to stir up and repack the resistor from time to time before starting the furnace. There is also a great heat loss due to its having to soak through the walls of the melting hole. The core or resistor always is at a much higher temperature than the inside of the melting hole, and sometimes the difference is so great that vapors of silicon may be streaming from the surface of the melting hole wall in contact with the resistor, while the temperature of the melting hole is no more than necessary for the proper melting of copper. The furnace, therefore, is not particularly efficient from a thermal standpoint, and as it is doubtful whether a granular resistance furnace can be improved to any great extent. Some other form should be devised that will incorporate the good features of the form of melting chamber we have described minus the disadvantages outlined.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Utilizing Copper Turnings

We have a lot of copper turnings that are mixed with small gravel from core sand. Can you give us a smelting flux to use when melting these turnings to pour into ingots?

The gravel can be fluxed off by converting it into a glass by the addition of sodium carbonate (soda ash) with about one-third of its bulk of slacked lime. Mix the turnings with their gravel and the soda and lime together, using about one part flux to eight of turnings and melt at a high temperature. If the slag is not sufficiently fluid, add more flux. Fluorspar also is excellent to use for this purpose.

Improper Melting Methods

We are experiencing unusual difficulties from spongy metal and castings containing blow-holes. These sections are designed for heavy rings for generators. The mixture we are using consists of 90 per cent copper, 9 per cent tin, and 1 per cent phosphor-tin.

Your difficulty is due to carelessness in melting, as the amount of deoxidizer added is sufficient to produce good results if the metal is handled properly in the furnace and if it is removed immediately when melted. While the copper is melting, it should be covered with charcoal, broken fine. When the copper is molten, it should lay quiet under the charcoal and must not bubble as if boiling, as otherwise the castings poured will be spongy. We suggest the addition of some suitable flux, as described in the advertising columns of *The Foundry*. These fluxes are valuable in metallurgical operations because they melt and form a coating over the melted metal, which is impervious to the heated furnace gases.

Castings Subjected to Hydrostatic Test

We are making brass castings that are subjected to hydrostatic pressure, but these leak when the pressure reaches 30 to 40 pounds. We are using the following mixture: Copper, 87 per cent; tin, 7 per cent; lead, 1 per cent, and zinc, 5 per cent.

An inspection of the fractured surface of the casting submitted indicates that the cause of the leakage is due to the oxidation of the metal while in the furnace. There is no good reason why an alloy consisting of 7 per cent tin and 5 per cent zinc should not show a perfectly homogeneous fracture and if it does not, it indicates that there is something wrong with the melting process. However, the use of a small percentage of manganese-copper or phosphor-copper should correct this difficulty. The amount used should be less than 1 per cent. The exact proportion can be determined readily by a few trial meltings, in which successively decreasing amounts of either of the deoxidizers mentioned may be used.

The test provides for casting in a sand mold, a bar 1 inch square and 6 inches long, and when cold it should be nicked and broken to permit of an examination of the fracture. A mixed fracture, that is one that appears to include several differently colored alloys, is an indication of the use of too high a percentage of the deoxidizer.

Copper-Plating Aluminum

Kindly let us know whether aluminum can be copper-plated?

Aluminum can be electro-plated with copper, but the process is not practical for commercial purposes. Several methods have been devised by which it is claimed perfect adherent coatings of copper can be successfully electro-deposited upon aluminum, but the adherency of the deposits invariably is of short duration. Aluminum has a great affinity for oxygen and when the

most careful treatment is given in the preparation of the surface before electro-deposition, a fine film of aluminum oxide forms, which prevents the perfect cohesion of the basic metal and its deposited coating. By repeated tests it has been found that when aluminum has been plated with an apparently sound adherent coating of copper and has withstood the burnishing test, that eventually, usually within from three to six months, small blisters appear and the deposit is rendered absolutely worthless.

Soldering Aluminum-Bronze Castings

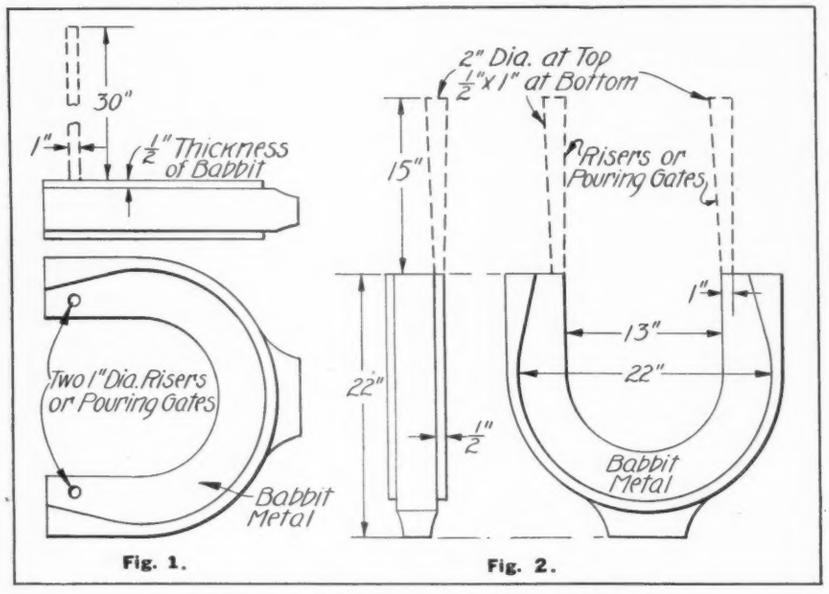
We are making aluminum-bronze castings composed of copper, 90 per cent; aluminum, 10 per cent, and iron, not above 1 per cent. We are experiencing difficulty in soldering the castings. Can you give us the mixture for a solder suitable for this alloy?

One of the disadvantages of aluminum bronze is the fact that it cannot be soldered. Thus far no solder has been found that will adhere to this alloy regardless of what flux is used. If castings are to be soldered they will have to be copper or nickel-plated. In soldering onto the plated metal care should be exercised to prevent rubbing the soldering iron on the plated surface as this will have a tendency to remove the coating of copper or nickel and it will be difficult to renew the surface again. One of the peculiarities of the tinsmith's business is that the operator always insists on scrubbing or rubbing the tinned surface with the soldering bit. This practice must be discouraged in the case of aluminum-bronze. After the article has been copper-plated, it can be soldered without difficulty by using a solder containing 60 per cent tin and 40 per cent lead.

Method of Babbitting Thrust Collars

What is the best alloy for welding-rods used for electric welding the butt joints of bronze liners on propeller shafts? We have found that the use of copper makes the joints hard and porous. We also would like to know which method of pouring babbitt thrust collars—the one shown in Fig. 1, or that illustrated in Fig. 2, will give the best results and produce good, solid metal. The steel thrust collars will be heated up before babbitt is poured on them. Is it the standard practice to always pour babbitt thrust collars under a 30-inch head of metal, and does that tend to make the metal more solid when the bearing surface is only ½-inch thick?

About the best alloy that can be used in this connection follows: Copper, 90 per cent; 15 per cent; phosphor-copper, 0.75 per cent, and tin, 9.25 per cent.



METHOD OF BABBITTING THRUST COLLARS

As far as the babbitt thrust collars are concerned, it will make no difference which way they are cast. The metal will not be any more solid when cast one way, than the other. We fail to see how these parts can be cast by the method shown in Fig. 1 without the use of a very complicated and cumbersome mold, as it is evident the 30-inch pouring gates would have to be sustained by sand or metal. Fig. 2 appears the most practical method of pouring these collars. The use of a head 30 inches high is unnecessary, as it has no influence on the solidity of the metal.

Analyses for Anti-Friction Metal

Recently we analyzed a sample of anti-friction metal, which contained the following: Lead, 55 per cent; antimony, 15 per cent; tin, 22 per cent; aluminum, 3 per cent, and copper, 5 per cent. We tried to duplicate this analysis, but the various ingredients seem to segregate and we would like to know how to overcome this difficulty.

The addition of aluminum to anti-friction metals is not recommended, as it increases the frictional resistance of the alloy and, therefore, it is better to leave it out. Also, if the copper is omitted the alloy will be more fluid and homogeneous. With 15 per cent antimony, the alloy should be sufficiently hard without the use of copper.

One satisfactory anti-friction alloy has the following composition: Lead, 67 per cent; tin, 21 per cent, and antimony, 12 per cent.

Mixtures of Alloys Similar to Duraluminum

We would like to have you furnish us with the formula of the alloy known by the trade name of "Duraluminum".

The following analyses contain the contents of the alloys known as "French" Duraluminum and are fairly typical:

Copper, 2.95 per cent; manganese, 0.81 per cent; iron, 0.55 per cent; silicon, 0.53 per cent and the remainder aluminum.

Copper, 4.05 per cent; manganese, 1.47 per cent; iron, 0.67 per cent; silicon, 0.60 per cent, and the remainder aluminum.

Copper, 3.30 per cent; manganese, 0.19 per cent; iron, 0.29 per cent; silicon, 0.22 per cent; magnesium, 1 per cent and the remainder of the mixture is aluminum.

Difficulties Arising from the Use of Lead

We make bushings and bearings from a mixture consisting of 80 per cent copper, 10 per cent lead and 10 per cent tin, using all new material and melting it in an open-flame furnace. We note that the castings are hard to machine although the metal looks clean. By the use of a magnifying glass, however the machined surface of the castings indicates the presence of many small pores and these wear out the machining tools rapidly. We have noticed that the more lead used in the mixture the greater the resulting difficulties, but in a mixture producing extremely hard brass without the use of lead the machining troubles do not occur.

The addition of lead to certain alloys of copper and tin will cause porosity in the castings under certain conditions of melting and many cases of porosity are due to this cause. In mixing bronze containing lead, add the latter metal last, after cooling the bath to the proper pouring temperature.

Do not add lead to very hot metal and when the percentage of lead is considerable, always use some deoxidizing agent. In the present instance the lead is partially volatilized and fumes attack the furnace lining forming lead silicate which is mixed with the metal and dulls the tools when the castings are being machined.

Probably other compounds of lead are formed which have the same effect. If the metal can be cooled before the lead is added, this is advisable. Also, a flux can be used to advantage; this should consist of plaster of paris with 5 per cent burnt borax and a sufficient amount should be added to form a thin slag over the surface of the molten metal.

This cover will prevent the vaporization of the lead and of the escape of the vapors that attack the lining of the furnace. Every precaution should be taken to avoid the oxidation of the metal while melting, as otherwise, oxide of lead is formed when the lead is added, which immediately attacks the lining of the furnace and results in the production of slags or mattes.

Making Castings for Pianos

We are engaged in the production of castings for pedals and other parts of pianos, but we have been advised that the alloy which we are using is not sufficiently stiff for the purpose of the purchaser. Our mixture consists of 12 parts of copper to 6 parts of zinc, and we would like to know whether the addition of tin would give us the desired qualities. We also find that the castings made from the foregoing mixture shrink excessively and do not run clean although molded entirely in the drag. Can you inform us how to overcome this difficulty?

On a percentage basis your mixture contains 66.67 per cent copper and 33.33 per cent zinc. This alloy is used extensively in rolling mills, but it is a difficult metal to handle in the foundry as it is quite a problem to prevent the zinc oxide from entering the castings as they are poured. We suggest changing the mixture, and if a yellow metal is desired, the following alloy will prove satisfactory: Copper, 70 per cent; zinc, 26 per cent; tin, 2 per cent, and lead, 2 per cent.

We believe that this mixture will prevent dirty castings and also other difficulties due to shrinkage, but no yellow brass mixture will make as desirable castings as red brass. For this reason it might be well to eliminate the yellow brass and substitute the following mixture: Copper, 88 per cent; zinc, 6 per cent; tin, 3.5 per cent, and lead, 2.5 per cent.

Cheap Red Brass Mixtures

We would like to obtain the formulas for several cheap red brass mixtures.

The following alloys generally are classed as cheap red brass alloys:

Copper, 76 pounds; zinc, 10 pounds; lead, 10 pounds, and tin 4 pounds.

Copper, 82½ pounds; zinc, 11 pounds; lead, 5 pounds, and tin, 1½ pounds.

Copper, 83 pounds; zinc, 8½ pounds, and lead 8½ pounds.

White Metal Pattern Alloy

We would like to obtain the formula for a white metal pattern alloy. At present we are remelting our old patterns, but this does not give satisfactory results.

What is generally conceded to be one of the best pattern alloys contains tin, 50 per cent, and zinc, 50 per cent. The alloy is made by first melting the zinc, which is followed by adding the tin.

The old patterns which you are using are liable to contain a large percentage of lead and for this reason it would not be advisable to mix this with the alloy given. To determine this, melt a small amount of the old pattern alloy heat it until red and if zinc fumes do not rise, you can assume the mixture contains a high percentage of lead. This also can be determined by its weight.

Use the following alloy to be mixed with the old pattern alloy, provided it is largely lead: Lead, 80 per cent; tin, 5 per cent, antimony 15 per cent.

Iron and Phosphorus Cause Hardness

Some of the brass castings we are producing are so hard that they turn the edge of our tools and we would like to know the cause of this difficulty. We are of the opinion that the metal is burnt in melting and we would like to know whether this causes the extreme hardness of the castings. The alloy consists of half scrap and half new metal and analyzes approximately as follows: Copper, 82 per cent; zinc, 7.5 per cent; tin, 4.5 per cent; lead, 5 per cent; antimony, 0.34 per cent; iron, 0.85 per cent, phosphorus, 0.01 per cent.

The hardness of the metal is due to the iron in the alloy in connection with the phosphorus contained therein. The latter element is very hard in such an alloy and we assume that hard spots are encountered when the alloy is machined. This is caused by the segregation of the iron, hardened by the phosphorus and tin. The iron cannot be removed in crucibles without taking out the other metal, as it must be eliminated by oxidation and, therefore, the zinc would oxidize first. The cheapest way to use this scrap would be to add more new metal and we suggest the use of 25 per cent of the scrap with 75 per cent of the new metal for the preliminary trial. Probably this mixture might contain too high a percentage of this scrap, but this can only be determined by experiment. Burning the metal will not produce hardness, although in the case of leaded alloys melted in contact with siliceous materials, it will cause the metal to become gritty and difficult to machine on this account. With the alloy given, burning would be productive of spongy castings.

Nomenclature of Aluminum Alloys

We have noted in THE FOUNDRY, *from time to time, reference to alloys such as aluminum No. 12 and No. 31, and again these are indicated as regular brass mixtures. We do not fully understand the meaning of these references.*

The only aluminum alloys that generally are known by number are Nos. 12 and 31. We believe that these alloys were so indicated by the manufacturers of aluminum and were used to designate these alloys when sold in the ingot form. The present practice is to purchase pure aluminum and to make the alloys as required. The formulas for alloys Nos. 12 and 31 were published in the November, 1915, issue of THE FOUNDRY page 461.

Brass mixtures are not generally known by number, as each manufacturer numbers his own alloys to meet his requirements. When gun metal is referred to, it is customary to write it 88-10-2, which means 88 per cent copper, 10 per cent tin and 2 per cent zinc. Another standard alloy is, 80-10-10, and means 80 per cent copper, 10 per cent tin and 10 per cent lead. As a rule, brass and aluminum alloys not only are indicated by numbers, but also the mixture usually is given.

Forgings for Fuse Caps

We are casting bars, 1¼ inches in diameter and 36 inches long, from which we cut slugs for making forgings for fuse caps. Some difficulty is experienced as a result of the flaking of the metal, which we believe is caused by the metal spilling on the lower side of the chill and adhering to it.

This difficulty can be overcome by castings the bars horizontally, but many manufacturers of these forgings have found that the trouble stated by you, combined with the tendency of the bars to pipe, are almost insurmountable obstacles in the production of these fuses from vertically cast bars. It would be a difficult problem to pour the bars so that the metal would not impinge upon the side of the mold and produce spills in a bar of the dimensions stated.

Advantages of Hand and Power Machine Molding

Each Type of Molding Machine is Adapted to a Certain Class of Work—The Author Outlines the Advantages of Each

By R Carrick

WHILE it is generally conceded that founding is the foundation of the engineering industry, and that modern industry depends upon the foundry for a large part of its products, yet it is surprising what a small proportion of the inventive genius that has been busily engaged for generations in the evolution of labor-saving machines has been devoted to foundry machinery. and it is only within comparatively recent years that machine molding has developed much importance as an art.

There is, however, abundant evidence that the deep-rooted prejudice that for a long time existed among foundrymen is gradually passing away. The unprecedented boom in trade, the withdrawal of certain trade union restrictions, coupled with the shortage of labor created by the war, has probably done more than a thousand papers or books could have done, to force the attention of foundrymen to the possibilities for improvement by the introduction of molding machines. One can hardly introduce this question without briefly referring to what we may term the stepping stones to machine, i. e., namely the odd-side, follow-boards and plates. It is surprising to what extent these very elementary means may be employed in improving both the quality of castings and in increasing the output.

The Use of the Joint Board

Probably the first stage in this development was the introduction of the joint-board, namely a flat board with planed face upon which the joint of half pattern, or the face of a flat pattern was laid.

This simple method saved time in ramming and gave a better joint when rolled over, also saving time in joint making. From this it was a very easy step to make a hard part in sand or plaster of paris for shaped joints, and in this way the odd-side came into existence, and with it the necessity for interchangeability in flasks or box parts. Following this came the time-honored match plate with fitted dowels and dowel-holes for the flasks, and carrying a portion of the pattern attached like a medallion. This system of plate molding is very popular in the light casting trade today, and splendid results are obtained both in the quality of castings and in the cost of production.

These early innovations were in themselves a form of machine molding, which could be adopted with every great advantage in many foundries today. The author cannot give with any degree of accuracy the date or even period of the introduction of molding machines in England, but as far back as the year 1800 an English patent was granted for molding screds, the patterns of which were backed out of the sand by lead screws of the same pitch. This was simply a pattern drawing machine of a rather ingenious construction, and so far as we are aware the English patent records do not touch again upon machine molding until 1839 when a very similar patent appeared. Machines for molding gears and pipes also appeared in the first half of the nineteenth century, but it is only within the last 25 or 30 years that molding machines have been used to any great extent in England.

Molding machines, both hand and power, may be classed under four heads. Machines that only ram the mold; machines which draw the pattern; machines that both ram the mold and draw the pattern; and lastly, machines in which every operation is mechanical, including sand-filling, ramming, pattern-drawing and conveying the finished mold away.

The first and second were the most popular machines in what we may term modern machine molding and although they are very simple pieces of mechanism compared with the modern machine tool or high speed engine, they accomplished nearly as great a revolution in the foundry as the latter did in the machine shop. There can be no doubt that in some foundries wonderful results were obtained in both quantity and quality of castings by the aid of these very simple devices. The foundries that adopted them, forged ahead and undoubtedly enjoyed a greater measure of prosperity than those which were content with the methods of hand molding. It is hardly necessary in these times to describe in detail the operation of these simple machines. The hand press or squeezer, as it is more popularly known, is largely used for small light work in iron and brass foundries. It consists simply of a strong table mounted on two stands to which is attached a press-head generally operated by a side lever. A board or hard part is placed on the table, the flask is put in position and filled with sand; the press-head is swung over and the sand is pressed. All other operations are accomplished in the ordinary way. There are hundreds of foundries in England where these machines might be adopted with advantage.

Popularity of Hand Turnover

The hand turnover machine has enjoyed a larger measure of popularity in this country than any other type of machine. The general principle of molding may be briefly described as follows. Plates, boards, plaster blocks or any kind of hard part may be attached to the top side of the revolving table by bolts, clips or screws. Bottom box is placed over it and rammed by hand. It is then clamped to the master part, the table is reversed and the mold left suspended. The lower table is then raised by means of side level until it is pressed firmly against the back of the box. The clamps securing the box to the master part, are released and the platform lowered steadily, the mold descending with it away from the patterns, the top table being rapped with mallet during the drawing process to ensure "free draw." The whole of these operations do not take more than 20 to 30 seconds in the hands of an expert operator. The resulting mold should not require any finishing and if there are no cores to insert, it should be ready to receive top part. It is astonishing what can be saved by these machines. Scores of illustrations may be given where 100, 200 and even 300 per cent has been saved in the cost of labor by taking jobs from the bench or floor and putting them on these machines, the cost of mounting the work sometimes only amounting to a few shillings. The saving in labor has not been the only advantage. There is a greater uniformity in the finished casting, and a much longer life for the pattern. There is scarcely any limit to the work that can be made on these machines, not only plain flat blocks, but very intricate castings that on the floor would require highly skilled molders. Nor are they limited to small work. There are machines of this type working ing in this country making castings weighing over a ton.

Nearly all the power machines on the

From a paper presented at the meeting of the Birmingham branch of the British Foundrymen's Association, Feb. 24, 1917.

market are either hydraulic or compressed air, the latter being most serviceable and popular. The hydraulic machines made by Bonvillian and Ronceray are intended primarily for repetition work. Stripping plates are largely used, the makers having perfected a system of their own for making stripping plates and stools. Only a slight amount of fitters' work is required, however intricate the casting may be. Nearly all the power machines in Continental Europe are hydraulically operated.

The compressed air machines undoubtedly are the most popular power machines. The Americans were the first to adopt compressed air as power for molding machines, and in the United States and Canada these machines have been brought to a very high state of perfection. All classes of castings, ranging in weight from a few ounces to 20 tons, are being made on these machines in that country.

Field of Power Squeezer

The power squeezer is adapted to the same class of work as the hand squeezer, but in the case of the former the machine does the squeezing and consequently the operator is less fatigued and can work faster. Moreover, greater uniformity in pressure can be had with the power squeezer, without putting any undue strain on the man, a point that is worth consideration. The transition from ramming only to both ramming and pattern drawing, is a very easy stage, but marks a great advance. A typical machine of the latter type is the Tabor power squeezing split pattern machine. Machines of this kind are particularly adapted to making molds from symmetrical patterns that can be split through the center or for flat back work. Patterns adapted to this machine are not, however, limited to the two classes mentioned, as any pattern that can be split on a true plane may bet molded on it. With symmetrical patterns but a single plate of patterns is necessary as the cope and drag are molded from a double set of half patterns, the impression of the right-hand set in the drag mating those of the left-hand set in the cope and vice-versa. In operating this machine the half flask is put in position over the pins in the flask frame of the machine and filled with sand. The yoke is then drawn forward and pressure is applied to the mold by pressing down the operating lever until the pressure gage indicates that the sand has been squeezed to the proper density. The yoke is thrown back, the sand is stricked off and the pattern drawing is accomplished by lifting the lever, which also starts the vibrator and raises the mold. The frame automatically drops back to its place immediately after the mold is lifted off. While these machines under ordinary conditions do not require a stripping plate, it is possible to fasten one to the flask frame to insure a perfect draw in the case of very intricate work.

Jar-Ramming Machines

Large work can be handled on jar or jolt-ramming machines. Almost any kind of a mold can be made on these machines, which not only do away with some of the hard labor of the molder, but performs the work more efficiently and in infinitely less time. Although jar-ramming machines are probably the latest development in foundry machines, jar-ramming is in all probability as old as the trade itself. There are few molders who have not in their first apprentice days made small cores by jarring and core-box on the bench to accomplish the ramming.

What is known as the plain jar-ramming machine consists of a huge plunger-base which rests upon a bed of concrete of given dimensions to form an anvil. On this plunger base is a bumper frame which encloses a cylinder and plunger and carries the jolting table. In some machines the bumper frame and jolt table are in one piece. Generally the stroke is of minimum length, and is adjusted to hard or light blows as desired by a back pressure valve, or by a variable stroke, which can be adjusted to the conditions required. It is essentially a sand-packing machine, the packing of the sand resulting from the impact between the table on which the mold is carried and the anvil on which it drops. To avoid unnecessary intensity in the blow struck by the table upon its anvil, a few layers of leather or other non-resilient material are introduced as a cushion. These reduce the wear and noise without having any material effect upon the action of the machine or sand. A machine of this type can be successfully used for ramming molds for either iron, steel, or brass and will ram any mold in a minute or less. The saving effected by its use on large work is equivalent to the time required to ram the mold by hand. Moreover, the sand is packed as it should be—densest at the surface of the pattern and of decreasing density above. This favors the escape of gases when the mold is poured, and eliminates venting to some extent.

Proper Use of Jar Machines

It is a mistake to try to ram all patterns in this way. Care must always be taken to avoid projections on the pattern which interfere with the proper flow of sand. This sometimes necessitates the use of a core not required for hand ramming, but the patterns when mounted for jarring require fewer repairs and the cost of adaptation of the jarring process is soon recovered. The practice adopted by the author is to have the patterns mounted on a board. If it is a repetition job a proper board forming the joint and following the contour of the patterns is made. If, however, only a few molds are required, an ordinary rough follow-board is used. The board pattern and flask are put on the machine table and filled with sand about 3 or 4 inches above the bottom part, by a laborer. The machine operator then opens the valve and jolts the mold, finishing off with a flat rammer and doing any necessary venting. The mold is then handed over to the floor-molder to be finished and made ready for pouring. In cases where the joint is not formed on the board, the cope is rammed by hand. Where a proper board is used the cope can be jarred like the drag. A machine operator and one laborer, working on a piecework basis can keep a gang of three or four molders finishing the molds.

The shockless jar-ramming machine accomplishes exactly the same work for the molder as the plain machine, but it is claimed that all ground shock is eliminated, Moreover, it is said that only a few inches of concrete is necessary for the foundation as distinct from the plain jar-ramming machine which delivers the entire blow upon the foundation.

Pattern Drawing Devices

Practically the same devices for pattern drawing have been utilized as additions to the jar-ramming, that are used in hand-ramming machines and other power machines. The addition of these drawing mechanisms resulted in giving the foundry a fairly complicated machine like the addition of an automatic lathe to the machine shops, and it can be fairly claimed that they represent to the foundry what the automatic does to the machine shop. While it will be readily admitted that the greatest advantage to be gained from these machines is in highly specialized and repetition work there is, however, a place for them in the average foundry.

Unfortunately many foundry managers and employers in the past have not been as successful with machine molding as they might have been, because having installed the machine they have not given the proper attention to the making of necessary tackle. Very often machines have been condemned, when, with judicious handling they might have become the most valuable asset in the plant. Not only must care and thought be used in selecting the right machines for the work, but equal care and infinitely more thought should be used in making the necessary tackle. Do not infer from this statement that

it is always necessary to put down very expensive tackle in order to make the machines a success. One should be guided by the class of work, number required, etc. Many times it will found that the outlay will be very little greater than in plants where floor molding is practiced.

False Arguments Against Machines

One of the most popular arguments against the machine is "Oh! we have not enough repetition work. Our work is always changing and we never get two jobs alike", and so on. But we have generally found that these arguments on the part of the foreman or manager are used as an excuse to save themselves a little trouble and labor, or to cover their prejudice. It is not always necessary to be making work by the hundred or thousand to use the machine successfully. The equipment accompanying a molding machine is usually found in a foundry whether a machine is used or not. The tackle consists of a dozen or two molding boxes that are interchangeable with a couple of planed plates and boards and a few loose runners or gates of different sizes. These are very elementary articles that neither involve any great amount of thought or expense, and may be the means of effecting considerable saving, as well as forming a stepping stone to greater things in machine molding. Of course, as we have previously stated, by far the greatest advantage to be derived by the machine is in repetition work, and there is little doubt that the tendency in the future will be to specialize and consequently there will be a greater scope for machine molding. In such cases where there is that tendency to specialize and where it is known that the work will be made on the molding machine, the foundry manager ought to be consulted before the work leaves the drawing office. Many times alterations can be made that will greatly facilitate the work being made on the machine, without in any way impairing its effectiveness for the work it has to do.

Experiments With Permanent Molds

On page 187 of the May, 1917, number of THE FOUNDRY, an abstract of a paper presented at the Birmingham branch of the British Foundrymen's association was published under the title "Experiments With Permanent Molds". It was stated that J. J. Howell was the author of this paper. This is incorrect, as the article should be credited to E. H. Broughall, of Alfred Herbert, Ltd., Coventry, Eng. The papers by Messrs. Broughall and Howell were presented as part of a discussion of the paper, "The Function of Feeders and Denseners," by J. J. Fletcher.

Pattern Economy in Molding a Fan Pedestal

By John H Eastham

IT IS safe to assume that the pattern storage of every foundry engaged in jobbing work contains one or more patterns used only once and in many cases only a slight variation of design or contour for a casting is responsible for the making of a new pattern which frequently could be avoided. Our shop recently received an order for two fan pedestals of the box type, 30 inches high, sectional and end views being shown in Fig. 1. The exact dimensions of these castings were not determined until most of the companion parts were ready for assembly, when a rough sketch was taken to the foundry with instructions to reduce the time and cost of production. As the base of the pedestal was of secondary importance, provided the head or bearing flange of the small end of the casting was of the correct dimensions, advantage was taken of this latitude to press into service an existing pattern, 5 feet long. When making the mold the following method was followed: At the correct distance from the small end of the pattern, machining and contraction having been allowed for, a new base flange was screwed into place on three sides, the piece carried in the cope having been doweled in the usual way, as indicated in Fig. 2. The pattern next was placed on a face board. The drag half of the flask was lowered over it and a stop-off bar or false end was built into the box 15 inches from the flange. Conical chaplet blocks with brick reinforcement were placed at four points on the pattern body. The drag half then was rammed and rolled over, the parting was made and the runner, riser and vent plugs were placed in position. Fig. 3 shows a cross-section of the mold at this stage. The cope was then rammed with ⅝-inch chaplet bars in their proper positions. The cope next was lifted off, the pattern drawn and the stop-off flange, Fig. 4, with core print attached, was lowered into place, sand having been rammed underneath and around the core print, this procedure being similar to that pursued in ordinary jobbing pipe foundry practice. The stop-off block next was drawn out, the mold finished and blackened, ¾-inch chaplets were placed on conical studs in the drag and the core was lowered into position. A skeleton

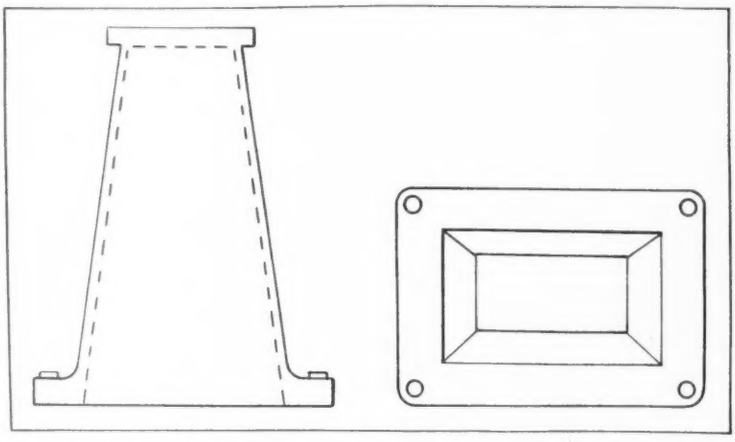


FIG. 1—SECTIONAL AND END VIEWS OF PEDESTAL CASTING

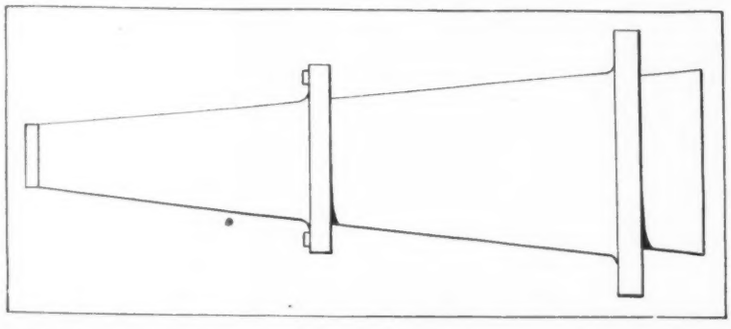


FIG. 2—METHOD OF ATTACHING BASE FLANGE TO THE PATTERN

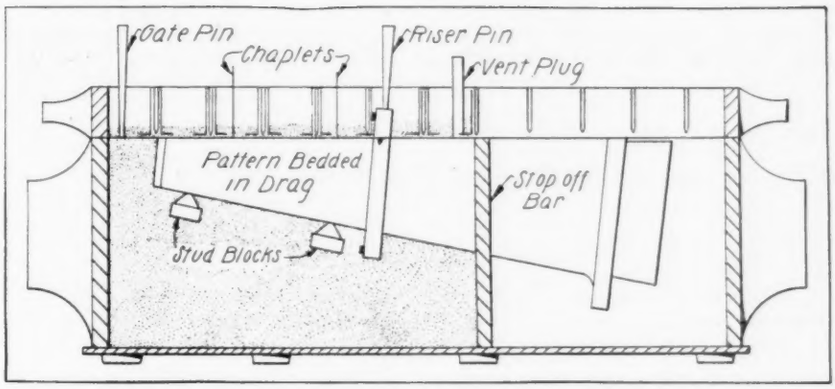


FIG. 3—CROSS-SECTION OF THE MOLD AT THE INTERMEDIATE STAGE OF ITS PRODUCTION

type frame of core box is employed with the stop-off piece attached to it to suit the casting and an additional 5-inch print length, a cast iron arbor having been used. The cope vent was carried out through the open end of the casting, as indicated in the cross-section of the finished mold, Fig. 5.

After the casting was made all charges were carefully checked and due allowance was made for overhead at ½ cent per pound. In this instance the overhead cost is lower than ½ cent. The cost of the castings made in this way, each weighing 295 pounds, was 2.03 cents per pound.

How to Make Chilled Cast Iron Balls

By W. J. Keep

Question:—Can you tell me how to make chilled cast iron balls, from 1 to 4 inches in diameter?

Answer:—I have never had much success in making chilled balls, even as small as 1 inch in diameter. Therefore, I consulted F. W. Seeman of the Lakeside foundry, Detroit, who says that it is very difficult to make castings of this kind. Whether they are gated on top, on the side or on the bottom, the metal will sink on the surface, sometimes at one point and sometimes at another with relation to the location of the gate. By gating on the side and by placing a riser on top and allowing the iron to flow through and out of the riser for a short time, a surface without imperfections generally will be produced. The chill should be heated before the iron is poured into the mold and this may be accomplished by pouring through the mold, about one-fourth as much iron as will be required to fill it. If too much iron is forced through, the chill will be decreased and will be prevented entirely. The quality of the iron will determine the amount of chill. A high chilling iron will give the best results. By pouring the iron into the mold, the chill will immediately be heated and, of course, will correspondingly produce a chilled casting.

In some way a shell should be formed on the casting before the iron in the center loses much of its heat. It should be sufficiently strong so that the iron inside of the shell shall solidify and cause all of the internal shrinkage to result in the formation of a coarse grain, or spongy spots at the center of the ball. The iron forms a thin skin the moment it strikes the surface of the chill; because of eddies caused by the flowing metal, some parts are more rigid than others. All of the heat which escapes from the

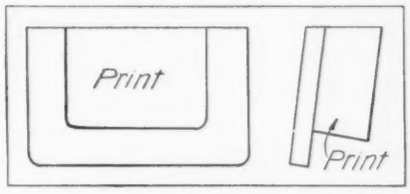


FIG. 4—END AND SIDE VIEWS OF STOP-OFF BLOCK

interior of the ball must pass through this skin and this keeps it plastic. When the center cools, the volume of the iron decreases as the result of shrinkage and the surface of the melted iron will be lowered, the plastic skin on the top following it causing a sink in the surface. If the upper skin has strength enough to retain its spherical form the sink would occur where a thin and plastic skin remains, or if all parts of the skin or shell are rigid the centers will be spongy.

Further information from readers of THE FOUNDRY is sought on this practice, since it seems to be engaging considerable attention at present.

How Fuel Oil Briquettes Are Used

Owing to the scarcity of coke, unusual interest is manifested by foundrymen in the use of fuel oil residue briquettes, which contain an unusually high percentage of carbon and, therefore, greatly increase the temperature of the metal. On the Pacific coast, where coke is unusually high-priced at the present time, fuel oil residue briquettes are being used extensively. In one shop on the Pacific coast, after the second or third charge, fuel oil residue briquettes constitute a part of the burden in the proportion, by volume, of 75 per cent of coke to 25 per cent of briquettes. The briquettes weigh 60 per cent more than the same amount of coke by volume. In charging the briquettes, it is the practice to first charge one-half of the coke then the briquettes, followed by the remainder of the coke for a single charge. In this way the coke, to some extent, prevents the briquettes from crushing.

A blacking for cores and molds recently patented in the United States consists of 49 parts of coke dust, 32.5 parts of charcoal, 22.5 parts of pipe clay and 3 parts of raw starch. When applied the various ingredients are bonded with starch paste, and it is contended that the blacking is suitable for coating molds for steel, iron, copper, bronze and aluminum.

A British inventor produces a polishing and rust-preventing composition by leaving cottonseed oil in contact with lead for periods as long as 10 days. The lead may be in any convenient form and the oil and lead are kept in a closed vessel. After the solution has been run off, the lead is exposed to the air for a time and then may be used to treat a further supply of oil.

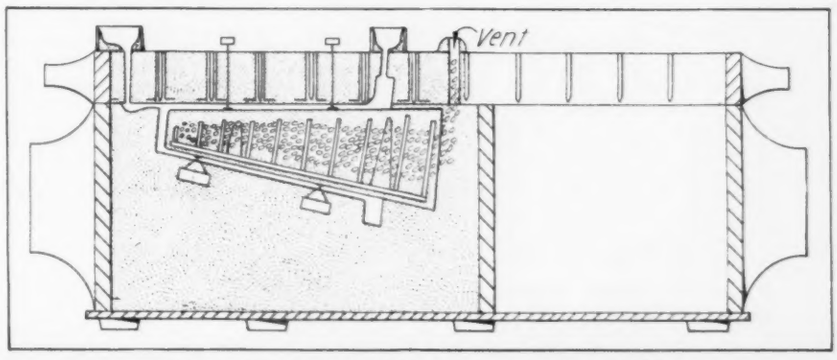


FIG. 5—CROSS SECTION OF THE FINISHED MOLD

Foundrymen Display Keen Interest in Boston Show

Number of Applications for Exhibitor's Space Promises to Exceed Previous Records—List of Reservations and Technical Papers Scheduled

WITH the total number of applications for space in Mechanics' building already in excess of the number of exhibitors at Atlantic City two years ago, and with the approximate floor area reserved considerably in excess of that occupied during that show, the success of the exhibition of foundry equipment and supplies, machine tools and accessories, to be held at Boston, Sept. 25 to 28, is assured. Indications now point to the greatest show of this kind ever held and it is probable that in number of exhibitors all records will be broken.

Manufacturers who have reserved space now are making preparations to ship their exhibits at an early date to avoid delays in delivery due to the congested condition of the railroads. As soon as delivered, all equipment will be stored in Mechanics' building until the date of the opening of the show. An added feature of the exhibit will be the display of motor trucks. Manufacturers of these vehicles have been extended an invitation by the exhibition committee of the American Foundrymen's association to display their products and a representative number of types undoubtedly will be displayed.

The complete list of manufacturers who already have reserved space follows:

Ajax Metal Co., Philadelphia.
Albany Sand & Supply Co., Albany, N. Y.
American Foundry Equipment Co., Cleveland.
American Gum Products Co., New York City.
American Lighting Co., Chicago.
American Molding Machine Co., Terre Haute, Ind.
Arcade Mfg. Co., Freeport, Ill.
Armstrong Cork & Insulation Co., Pittsburgh.
Atkins, E. C., & Co., Indianapolis.
Ayer & Lord Tie Co., Chicago.

B. & B. Mfg. Co., Indianapolis.
Beaudry & Co., Boston.
Berkshire Mfg. Co., Cleveland.
Besly, Chas. H., & Co., Chicago.
S. Birkenstein & Sons, Chicago.
Blystone Mfg. Co., Cambridge Springs, Pa.
Brass World Publishing Co., New York.
Brown Specialty Machinery Co., Chicago.
Buckeye Products Co., Cincinnati.
Bullard Machine Tool Co., Bridgeport, Conn.

Cataract Refining & Mfg. Co., Buffalo.
Chase, Frank D., Chicago.
Champion Foundry & Machine Co., Chicago.
Chicago Pneumatic Tool Co., Chicago.
Chisholm & Moore Mfg. Co., Cleveland.
Cincinnati Pulley Machinery Co., Cincinnati.
Cleveland Blow Pipe & Mfg. Co., Cleveland.
Cleveland Milling Machine Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Coale, Thos. E., Lumber Co., Philadelphia.
Cutter & Wood Supply Co., Boston.
Davis-Bournonville Co., Jersey City, N. J.
Debevoise-Anderson Co., New York.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Drouve, G., Co., Bridgeport, Conn.

Federal Foundry Supply Co., Cleveland.
Felt & Tarrant Mfg. Co., Chicago.
Forbes & Myers, Worcester, Mass.

Gardner Machine Co., Beloit, Wis.
General Electric Co., Schenectady, N. Y.
General Fire Extinguisher Co., Providence, R. I.
Goldschmidt Thermit Co., New York.
Great Western Mfg. Co., Leavenworth, Kas.

Harrison Supply Co., Boston.
Herman Pneumatic Machine Co., Pittsburgh.
Hill, Clarke & Co., Boston.
Hoevel Mfg. Corporation, New York.
Holz, Herman A., New York.

International Molding Machine Co., Chicago
Iron Age, New York.

Jennison-Wright Co., Toledo.

Kelley, T. P., & Co., New York.
King, Julius, Optical Co., New York.

Lewis-Shepard Co., Boston.
Lupton's, David, Sons Co., Philadelphia.
Lynd-Farquhar Co., Boston.

McCrosby Reamer Co., Meadville, Pa.
McLain's System, Milwaukee, Wis.
MacLean Publishing Co., Toronto, Ont.
Malleable Iron Fittings Co., Branford, Conn.
Metal Industry, New York.
Michigan Smelting & Refining Co., Detroit.
Midland Machine Co., Detroit.
Monarch Engineering & Mfg. Co., Baltimore.
Mott Sand Blast Mfg. Co., Brooklyn, N. Y.
Mumford, E. H., Co., Elizabeth, N. J.
Mumford Molding Machine Co., Chicago.

National Engineering Co., Chicago.
New England Coal & Coke Co., Boston.
New Haven Sand Blast Co., New Haven, Conn.
Nicholls, Wm. H., Co., Brooklyn, N. Y.
Norma Co. of America, New York.
Norton Co., Worcester, Mass.

Obermayer, S., Co., Chicago.
Osborn Mfg. Co., Cleveland.
Oxweld Acetylene Co., Newark, N. J.

Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia.
Penton Publishing Co., Cleveland.
Pickands, Brown & Co., Chicago.
Pittsburgh Crushed Steel Co., Pittsburgh.
Portage Silica Co., Youngstown, O.
Pridmore, Henry E., Chicago.

Quigley Furnace Specialties Co., New York.

Railway Mechanical Engineer, Chicago.
Richey, Browne & Donald, Maspeth, N. Y.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Robeson Process Co., New York.
Rogers, Brown & Co., Cincinnati.

Sand Mixing Machine Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Simonds Mfg. Co., Fitchburg, Mass.
Sly, W. W., Mfg. Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Smith, Werner G., Co., Cleveland.
Standard Equipment Co., New Haven, Conn.
Strong, Kennard & Nutt Co., Cleveland.
Sullivan Machinery Co., Chicago.

Thomas Iron Co., Boston.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

United States Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
United States Silica Co., Chicago.

Wallace, J. D., & Co., Chicago.
Warner & Swasey Co., Cleveland.
Wheeler & Holcomb Co., Chicago.
White & Bro., Philadelphia.
Whitehead Bros. Co., Providence, R. I.
Whiting Foundry Equipment Co., Harvey, Ill.
Woodison, E. J., Co., Detroit.

Technical Program

That the technical features of this great gathering of foundrymen have not been neglected is reflected by the 44 papers that already have been secured, and to these must be added a large number of committee reports. The Boston meeting will be opened on Tuesday morning, Sept. 25, in place of Monday afternoon, as at Cleveland last year, and morning sessions only will be held, closing Friday, Sept. 28. Simultaneous sessions for the consideration of papers on gray iron, steel and malleable iron will be necessary to dispose of the lengthy program that has been prepared. Registration will open at the Copley-Plaza on Monday morning, but on Tuesday the headquarters will be transferred to Mechanics' building, where they will be continued throughout the remainder of the week.

The papers scheduled on the program, follow:

Symposium on "Military Stores":
"Making Shells in Permanent Molds", by Edgar A. Custer, Philadelphia.
"Military Stores", by Dr. F. C. Langenberg, Watertown Arsenal, Watertown, Mass.
"Small Steel Castings for Ordnance Purposes", by Major C. M. Wesson, Watertown Arsenal, Watertown, Mass.

Symposium on "Refractories":
"Refractory Materials Employed in the Metallurgical Industries", by H. C. Arnold, University of Illinois, Urbana, Ill.
"Cupola Refractories", by G. E. Jones, Whiting Foundry Equipment Co., Harvey, Ill.

"Factors Contributing to the Economical Use of Grinding Wheels in the Foundry", by Wallace T. Montague, Norton Co., Worcester, Mass.

"Results of Tests in Blending and Mixing Sand by Means of Mullers", by R. F.

Harrington, Hunt-Spiller Mfg. Corporation, Boston.

"Experiences with Sand Mullers from their Conception to Their Final Application to the Foundry Industry", by P. L. Simpson, National Engineering Co., Chicago.

"Fillet-Sizes", by Frank E. Jones, University of Kansas, Lawrence, Kans.

"Sand-Blasting", by H. L. Wadsworth, Sand Mixing Machine Co., Cleveland.

"Efficiency in the Foundry", by Jas. A. Fitzgerald, Reno, Pa.

"The Metals of Technology", by John Ritchie Jr., Mass. Institute of Technology, Boston.

"Welfare Work in Southern Foundries", by J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.

"Co-operative Shop Training", by W. B. Hunter, Industrial Department, Fitchburg High School, Fitchburg, Mass.

"Scientific Selection of Men", by Wm. Judson Kibby, Cleveland.

"Co-operation", by the Chicago Foundrymen's Club.

"The Labor Situation as Relating to Co-operation Between the Employer and the Employe", by G. E. Mac Ilwain, Babson's Statistical Organization, Wellesley, Mass.

"The Relationship of the Engineering Department to the Pattern Shop and Foundry", by F. J. McGrail, Struthers-Wells Co., Warren, Pa.

Gray Iron

"Seasoning Gray Iron Castings", by L. M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I.

"The Foundry from the Viewpoint of the Sales Engineer", by H. R. Atwater, Osborn Mfg. Co., Cleveland.

"The Effect of High Sulphur in Agricultural Machinery Castings", by T. Mauland, International Harvester Co., Chicago.

"The Use of the Microscope in the Foundry", by R. J. Anderson, Cleveland Metal Products Co., Cleveland.

"Modern Centrifugal Cupola Blowers", by J. W. Shugg, General Electric Co., Schenectady, N. Y.

"Making Small Cores Under Economical Conditions", by R. E. Kennedy, University of Illinois, Urbana, Ill.

"Effect of Cupola Practice on the Quality of Iron", by G. S. Evans, Lenoir City, Tenn.

"Briquetting Foundry Borings", by A. L. Stillman, General Briquetting Co., New York.

"Effect of the Presence of Iron Oxide in Molding Sand", by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

"Machine-Made Cores", by Lewis G. Blunt, Romeo Foundry Co., Port Huron, Mich.

Steel

"Molding and Casting Large Slag Pots", by C. J. McMahon, Illinois Steel Co., Chicago.

"Recent Progress in the Application of the Electric Furnace to the Melting Problem", by C. H. Booth, Snyder Electric Furnace Co., Chicago.

"Discussion of the Electric Furnace from the Central Station Standpoint, with a Discussion of Power Rates and Measuring Power on a Maximum Demand Basis", by E. L. Crosby, Detroit Edison Co., Detroit.

"Data on the Treatment of Cast Iron in the Electric Furnace", by Jos. L. Dixon, John A. Cowley Co., Detroit.

"Description of a Small Open-Hearth Furnace", by David McLain, Milwaukee.

"Welding", by M. Stuart Plumley, Davis-Bournonville Co., Boston.

"The Use of Vanadium in Steel Castings", by J. Lloyd Uhler, Union Steel Castings Co., Pittsburgh.

"Comparison of the Electric Furnace and the Steel Converter for the Manufacture of Small Steel Castings", by C. R. Messinger, Sivyer Steel Casting Co., Milwaukee.

"A New System of Burning Crude Oil", by W. A. Janssen, Bettendorf Co., Davenport. Iowa.

Malleable Iron

"Waste Heat Boilers as Applied to the Malleable Melting Furnace", by A. W. Pratt, Babcock & Wilcox Co., New York.

"The Application of Pulverized Coal to the Malleable Melting and Annealing Furnace", by Jos. Harrington, Chicago.

"Application of Waste Heat Boilers to the Malleable Melting Furnace," by C. D. Townsend, Danville Malleable Iron Co., Danville, Ill.

"Strength of Malleable Iron", by Prof. Enrique Touceda, Albany, N. Y.

"Application of Pulverized Coal to the Malleable Melting Furnace", by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

"Malleable Iron Annealing; Comparative Carbon Losses and Muffle vs. Pot Ovens", by J. B. Deisher, T. H. Symington Co., Rochester, N. Y.

"Troubles Encountered in Machining Malleable Iron; Causes and Remedies", by A. T. Jeffery, Dayton Malleable Iron Co., Dayton, O.

A New Method of Making High-Speed Steel

A method of making high-speed steels containing tungsten, chromium and vanadium which consists in adding the alloying metals in the form of a hardener to a bath of molten iron, has been made the subject of a patent by Isador Ladoff, Wilkingsburg, Pa. The hardener is made by the simultaneous reduction of the oxides of tungsten, chromium and vanadium, with sufficient oxide of iron to form an alloy containing 50 per cent of the latter, and 50 per cent of tungsten, chromium and vanadium together, the latter three elements being in their respective *interrelated proportions* to form the desired alloy, when the hardener is added to the bath of molten iron or steel. The object of making this hardener, as disclosed by the inventors is to simplify the present process of producing high-speed steels by making the alloy in two operations instead of several, as at present. The two operations comprise making the hardener and then incorporating the same in a bath of iron or steel, in proportions necessary to form the desired high-speed steel. By the usual method, the alloying elements are first reduced to metal, or are made into a ferroalloy and then are added separately to the bath of steel, or are melted together with the steel in the proportions required. The invention reduces the steps necessary to produce such alloys.

The National Founders' Association has moved its New York office from 141 Broadway to 90 West street, New York. The office continues in charge of C. W. Burgiss, eastern representative.

To Increase the Melting Capacity of a Small Cupola

By W. J. Keep

Question:—Our cupola is home-made and while we have hot iron at the beginning of the heat, nevertheless, as the heat progresses the flow of the iron slows up almost entirely and slag and iron accumulate between the tuyeres and toward the center until there is only a small opening left. The cupola is 30 inches inside diameter, the blast being furnished by a fan. The wind box is 8½ x 9 inches and extends two-thirds around the cupola. The blower outlet is 10 inches in diameter and the four tuyeres each have a diameter of 3¾ inches. The air pressure is 4½ ounces and the blower motor is 7-horsepower.

Answer:—I hardly think that you can do good work under present conditions, even if you should make some changes in your cupola. It is somewhat difficult to obtain good results with a 30-inch furnace unless the foreman or melter is well versed in cupola operations. We obtain magnificent results with a cupola 22 inches in diameter melting a two-ton heat. I have used a furnace, 16 inches in diameter, on a 500-pound heat. Also, at present I am using a cupola lined to 28 inches to produce heats from 2½ to 5 tons. You may be trying to melt too much iron, since three to five tons would be the limit and you may now be doing this before your trouble actually begins. I suggest that the pig iron be broken into pieces weighing approximately 25 pounds and the scrap likewise should be broken into pieces of this size. Charge carefully and evenly, using 20 pounds of coke for each 100 pounds of iron. Also be careful not to charge dirt or sweepings from the charging floor. The silicon should be increased to about 2.50 per cent. The cupola should have six tuyeres, 8 inches wide and 3 inches high in the opening. Leave an 8-inch blank space in the back. The bottoms of the tuyeres should be at least 10 inches from the sand bottom and this distance should be greater if you need more iron for a casting than you can catch in ladles. Make a slag hole in the back of the cupola and tap the slag as soon as it will come down. Use a two-quart measure of good limestone on each charge, which should be broken as small as a hen's egg. The blast pressure should be six or seven ounces, requiring only a 5-horsepower motor.

The Federal Foundry Supply Co., Cleveland, has acquired the building and site which it now occupies on E. Seventy-ninth street.

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Take Advantage of This Opportunity

IN THE few months since the United States entered the war, the wheels of preparedness machinery have been set in motion with a swiftness that has surprised even the most optimistic. Every day new contracts are announced which impose additional strains on overtaxed manufacturers. The gigantic programs of shipbuilding, aeroplane manufacture, munitions-making and military camp construction insure work for every branch of industry. Every maker of steel, gray iron, malleable or nonferrous castings is abundantly supplied with orders.

The rapidity with which much of this war business has developed and the novelty of some of the work foundries are asked to produce challenges the resourcefulness of foundrymen. As pointed out in the May issue of THE FOUNDRY, the events of the past few years have prepared the industry for the present conflict, but the newest preparedness campaign presents problems which cannot be solved by dint of previous training or experience. To retain the confidence gained in the past, makers of castings must promptly and successfully work out solutions of the fresh complexities and American ingenuity must find a means of increasing the production without lowering the quality.

The unusual responsibility thrown upon foundrymen should not be regarded as a burden; it should be welcomed as an opportunity for demonstrating efficiency and resourcefulness. The foundries of European belligerents, which before the war were far behind American plants in their development, have made a fine record of achievement. The opportunity to surpass our Allies in this respect is ours. Let us take advantage of it.

Trade Outlook

DURING the past month, the price of pig iron has passed the $50 mark, and now is well on its way to the $75 level. Authorities who are familiar with the market claim that there will be a shortage of foundry and malleable pig iron during the next year. The coke situation remains unaltered, the labor supply and car shortage being the limiting factors. Bessemer iron is held at $55, valley, and basic from $50 to $52, valley. No. 2 foundry iron is quoted in the leading trade centers as follows: Pittsburgh, $53.95 to $55.95; Chicago, $52.50; Cleveland, $50 to $51; Buffalo, $47 to $50; Birmingham, $43 to $45; and Philadelphia, $48.50 to $49.50. Malleable pig iron is listed at $53.95 to $55.95, Pittsburgh; $52, Chicago; and $47 to $50, Buffalo. Lake Superior charcoal iron is quoted at $55 to $57.50, Chicago. Prompt foundry coke is selling from $12 to $12.50, Connellsville, and fuel for second half delivery is quoted at the same price. Ferromanganese is quoted at $425 to $475, Pittsburgh, and 50 per cent ferrosilicon is held at $250, Pittsburgh. Heavy melting steel sells at from $33 to $47.

Equipment for Reclaiming Core Sand

A continuous core reducer recently developed by the National Engineering Co., Chicago, is shown in Fig. 1. It consists of a horizontal iron drum of heavily reinforced sections bolted to circular end pieces fitted with trunnions on which it is revolved by gears taking power from a belt. In operation it is similar to a tumbling barrel, except that the side sections are perforated for the escape of the sand when it has been sufficiently broken apart. The side sections can be removed to give access to the interior and remove the accumulation of core rods and wires when necessary. Usually, as many of the rods as possible are removed before the cores are passed to the reducer, a magnetic separator being efficient in taking out such as may be loosened from the sand.

The reducer illustrated is 4 feet in diameter, 6 feet long, weighs 6 tons and operates at 20 revolutions per minute. The holes are spaced 1½ inches and are ⅛ inch in diameter on the inside of the plate, flaring to ⅝ inch on the outside.

In practice the cores are fed from a belt into the hopper at the right of the illustration. In the drum the material is brought into contact with steel or iron balls, pieces of pig iron or other heavy material. The revolution of the drum causes the heavy objects to break up the cores and as fast as the sand reaches a sufficient degree of fineness it sifts through the holes to the floor and thence is conveyed to storage.

Function of Screen Separator

In one installation the reclaimed sand passes over a screen separator which removes the coarse and fine particles and retains the middles, which drop into a bin above the mixer. This separator, also made by the National Engineering Co., consists of two screen surfaces, one of 30 mesh and one of 70 mesh, the material passing through the coarser and over the finer screen being the portion saved. The separator is shown in Fig. 2.

Sand from the bin is fed through a gate in the bottom to the pan of a foundry mixer where binder, new sand and water are added, each being fed from a suitable container arranged to deliver its contents into the mixer. With this arrangement one man can control the mixing of 6 to 8 tons per hour of core material.

An analysis of Michigan City sand, such as is used for coremaking, shows that it is made up of the following sized grains:

	Per cent
20 mesh	0.3
40 mesh	7.3
60 mesh	63.5
80 mesh	23.5
100 mesh	5.1
Through	0.3
	100.0

From this it will be noted that 60 to 80 per cent of the sand would fall between 30 and 70 mesh screens.

Personals

Louis Lesperance, formerly located at Kokomo, Ind., has been appointed superintendent of the foundry operated by the Rumsey Pump Co., Seneca Falls, N. Y.

W. J. Scholes has been appointed superintendent of the foundry branch of the General Motors Co., located at Stockton, Cal., where gas tractors are manufactured.

The Goldschmidt Thermit Co., New York, manufacturer of ferroalloys and metals, is erecting a welding plant, 35 x 106 feet, on Western avenue, Pittsburgh.

Louis Rasmussen, superintendent of the Wisconsin Aluminum Foundry Co., Manitowoc, Wis., has resigned to accept a position at Marshalltown, Ia.

Robert Parks, formerly general manager of the Bettendorf Co., Bettendorf, Ia., now is associated with the Canadian Car & Foundry Co., Montreal.

J. H. Steedman, vice president and general manager of the Curtis Pneumatic Machinery Co., St. Louis, has been appointed a lieutenant in the United States navy.

Henry F. Russell has resigned from the sales force of the Lumen Bearing Co., Buffalo, to become sales manager of the foundry division of Farrar & Treffts, Buffalo.

I. S. Fouse, formerly associated with the Standard Steel Car Co., Pittsburgh, with works at Butler, Pa., now is general manager of the Allegheny Foundry & Machine Co., Glassmere, Pa.

James H. Slawson, Chicago sales agent of the National Malleable Castings Co., Cleveland, has been elected vice president of the Joliet Railway Supply Co., Joliet, Ill., a subsidiary of the Northwestern Malleable Iron Co., Milwaukee.

T. N. McEuen has been appointed representative of the E. J. Woodison Co., Detroit, manufacturers of foundry and platers' supplies, in the states of Iowa and Nebraska, Mr. McEuen formerly was attached to the Milwaukee office of this company.

Arthur F. Braid has assumed the duties of metallurgical engineer in charge of metal sales of the Goldschmidt Thermit Co., Jersey City, N. J. He succeeds de Courcey Brown, who has joined the officers' reserve corps at Plattsburg, N. Y., and probably will continue in the service of the army.

David Evans, president of the Chicago Steel Castings Co., Chicago, and senior partner of the David Evans & Co., Chicago representatives of the Sloss-Sheffield Steel & Iron Co., is serving the government as captain of a motor truck company at Fort Sam Houston, Texas. Mr. Evans served in the Spanish-American war.

Robert Radford has been elected president of the Southwark Foundry & Machine Co., Philadelphia, succeeding W. L. Abbott. Mr. Radford began his business career with the Baldwin Locomotive Works in 1894. For the past few years he has filled the office of secretary-treasurer of the Standard Steel Works Co., Philadelphia, with plants at Burnham, Pa., and will continue in this capacity.

C. A. Newman, formerly manager of sales promotion for Henion & Hubbel, Chicago, dealers in power pumps, mining and mill supplies, has been

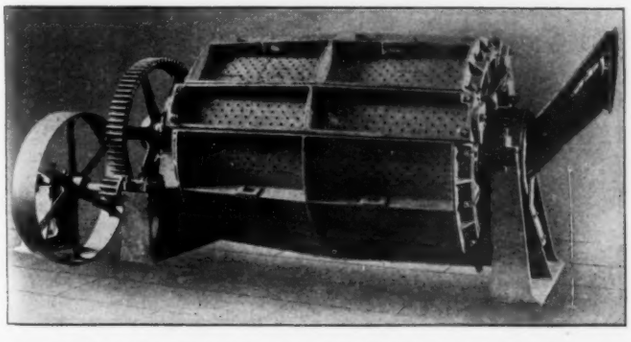

FIG. 1—MACHINE FOR REDUCING CORE SAND

FIG. 2—SCREENS ELIMINATE COARSE AND FINE PARTICLES

appointed sales manager of the Boiler-Kote Co., Fisher building, Chicago.

G. S. Evans, who recently resigned as superintendent of the foundry of the Lenoir Car Works, Lenoir City, Tenn., is engaged in the construction of a large steel and gray iron foundry and machine shop at Atlanta, Ga., and he will be placed in charge of the operations of this plant when it is completed.

Henry M. Leland, general manager of the Cadillac Motor Car Co., Detroit, and his son, Wilfred C. Leland, who have been prominently connected with the perfection of gasoline engines, have announced their retirement from the automobile industry to devote their time and interests to the call of the nation. They are dedicating their services to the task of building a powerful aeroplane fleet which will give the United States the mastery of the air in the present war. R. H. Collins of Detroit succeeds Mr. Leland as general manager of the Cadillac Co., and for the last two years he has been assistant to President W. C. Durant of the General Motors Co.

Joseph Harrington, advisory engineer in the use of powdered coal as fuel, has organized the United States Power & Furnace Co., with headquarters at 208 South La Salle street, Chicago. This corporation will enable Mr. Harrington to enlarge greatly the scope of his activities and will enable him further to promote economies in the use of coal as fuel in industrial practice. The United Power & Furnace Co. is prepared to design and construct powdered coal installations, metallurgical and special furnaces, steam power plants, pumping stations and all apparatus for the economical burning of fuel. The officers of the company follow: Joseph Harrington, president; Carl Heim, secretary and treasurer, and William A. Nelson, vice president and general manager.

The Schwartz Deoxidizing and Refining Process

A process for deoxidizing and refining ferrous metals is the title of a patent granted to Edward H. Schwartz, Chicago. It consists of melting in a cupola, a mixture of high carbon and manganese steel scrap, or spiegeleisen and high silicon pig iron, with a suitable amount of limestone as a flux, with the object of obtaining a product of relatively high carbon content, which can be converted into steel by treatment in an electric, open-hearth or reverberatory furnace or in a converter, or can be used as cast iron suitable for machinery castings or for car wheels. To make the latter, a mixture of 40 per cent pig iron containing 1 per cent silicon and 0.4 per cent manganese is made with 30 per cent of steel scrap and 30 per cent of cast malleable iron railway scrap. This is melted in a cupola from which it is transferred to an open-hearth refining furnace where sufficient spiegeleisen is added to bring the manganese to about 0.8 per cent, and enough ferro-silicon to bring the silicon content to approximately 0.75 per cent. The metal then is refined until the silicon is reduced to 0.6 per cent and the manganese to 0.75 per cent, when the inventor states the whole mass of metal will have been thoroughly deoxidized and refined and may be cast into wheels.

Core Compound Manufacturers Beware!

That the merits of core compound are not generally appreciated by casting manufacturers is indicated by the following acknowledgment from a southern foundryman, of a circular devoted to "Ebony Core Compound", issued by the Hill & Griffith Co., Cincinnati:

The Hill & Griffith Co.
Sir youre cirkler recieved without date as menny others has bin

while I respecte you as gentlemen I beg to call youre attensian to my experiance on Core Compound.

in date of 1895 *I bought one Brl. of the very beste core compount that human tung could describe it incloosive don away withe all cavles and furnished evreythin nessary to make porfect castings in all respects.*

I supose I moste opend the Bbl at the rong ende as it prooved oposet fram recamendation

my first thought after givin it a trial was to throw it in mud hole on street.

I was afrade I would git in truble withe city about blowing up the street. my next though I would throw in in mere by creek.

I ferde I would blow up som mill acrost the cree below. I found it was insacnt if let alone. I furnish it Hooseroon and worked around it fourteen years to keepe fram havin enny moore truble withe core compound.

in date of 1909 *my pland got consumed by fire and relieved me of this mizrable Bbl of core compound.*

no more core compound for me if you plese.

Death of W. W. Green

W. W. Green, president of the Garden City Fan Co., Chicago, died at his home in Niles, Mich., Saturday, June 2. Mr. Green was born at Williamston, Mass., Dec. 9, 1838, but in 1872 moved to Chicago and established the plant of which he was president many years. In 1902 the works were moved to Niles, Mich., and Mr. Green established his home in that city.

Gray and Benjamin, Advertising Counsellors

A. A. Gray and Charles L. Benjamin have organized the firm of Gray & Benjamin, with headquarters in the Transportation building, Chicago, and will serve as advertising counsel to manufacturers of electrical, mechanical, chemical and kindred products. They will analyze and report upon problems of manufacture and distribution and will supervise the preparation of advertising copy for technical and trade papers, booklets, house organs, catalogs and incidental advertising propaganda. Mr. Gray was managing editor of the *Electrical Review and Western Electrician* for many years and also served a term as president of the Federation of Trade Press Associations, and more recently, was president of the Associated Business Papers, Inc.

Mr. Benjamin has been engaged in advertising work since 1888. For a period of nine years, he was advertising manager of the Cutler-Hammer Mfg. Co., Milwaukee, and for the past two years he was engaged in advertising work on his own account, acting and advertising counsel to a number of manufacturers of nationally known products.

Specifications for Soil Pipe

(*Continued from page 270*)

little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

6.—When placed horizontally upon supports 12 inches apart and tested under a centrally applied load, the arbitration test bars, specified in Section 5, shall show a transverse strength of not less than 2500 pounds, and the deflection shall not be less than 0.1 inch.

7.—All pipe shall be tested to a hydrostatic pressure of not less than 50 pounds per square inch before coating. Any casting showing defects under this hydrostatic test shall be promptly broken and returned at once to the cupola.

Standard Sizes and Weights

8.—(*a*) The inside diameter of the barrel of any pipe or fittings or branch thereof shall not vary more than ⅛ inch under the nominal size of pipe.

(*b*) The outside diameter of the barrel of pipe and fittings shall be ½ inch greater than its nominal inside diameter. A variation in the outside diameter of ⅛ inch over or under these figures will be permitted.

(*c*) All pipe and fittings shall be of uniform thickness of wall and present true circles at the hub and spigot ends. A variation of $\frac{1}{32}$ inch under the following dimensions will be permitted, but only when the actual weight is not less than the variation of the marked

or estimated weight as given in Tables I and II:

Thickness of:	Inch
Barrel	¼
Body of hub	5/16
Bead of hub	½
Bead of spigot end	5/16

9.—(*a*) Weights and measurements of pipe and fittings shall be taken as those of plain uncoated pipe. All weights shall be given in pounds.

(*b*) Individual lengths of pipe and fittings may weigh 5 per cent less than designated in Tables I and II, but only when the average weight of a given size and weight of pipe and fittings selected at random, is not less than that shown in Tables I and II.

(*c*) The regular length of pipe shall be such as to lay 5 feet including hub.

(*d*) The average weights of soil pipe and fittings shall not be less than those given in Tables I and II.

Table I.
WEIGHTS OF SOIL PIPE

Size, inches	Single hub: Per 5-foot length, pounds	Single hub: Per foot including hub, pounds	Double hub: Per 5-foot length, pounds
2	27½	5½	27½
3	47½	9½	47½
4	65	13	65
5	85	17	85
6	100	20	100

10.—(*a*) All pipe and fittings shall be practically straight and cylindrical and fittings true to pattern. The specified sizes shall be for the inside diameter and shall conform, within the allowable variation, to the dimensions given in the tables.

(*b*) All pipe and fittings shall be carefully examined for defects and sounded with a hammer before shipment. No fillings with metal, cement or other material, or so-called burning-on of iron will be permitted. The castings shall be sound and free from cracks, sand-holes, blow-holes and cold-shots.

11.—All pipe and fittings shall be marked with the manufacturer's name or appropriate initial. Every casting shall have cast upon it the minimum or estimated weight of the same as shown in Tables I and II.

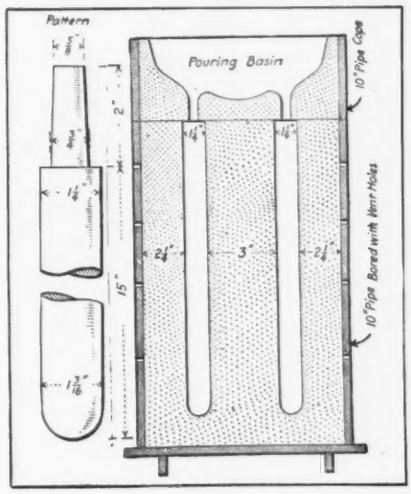

FIG. 1—MOLD FOR ARBITRATION TEST BAR

to interfere unnecessarily with the operation of the works, and shall be made prior to shipment, unless otherwise specified.

13.—All pipe and fittings which fail to conform to the provisions of these specifications shall be subject to rejection.

Tentative Specifications for Railroad Malleable Castings

1.—The castings shall be produced by either the air furnace, open-hearth or electric furnace process.

2.—Tension test specimens specified in Section 5 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch	45,000
Elongation in 2 inches, per cent	7.5

3.—Transverse test specimens specified in Section 5, tested with the cope side up on supports 12 inches apart, pressure being applied at the center, shall sustain a load not less than 2100 pounds, and show a minimum deflection of 1.125 inch.

Table II.
WEIGHTS OF SOIL PIPE FITTINGS

Only the Staple Fittings are Shown. From the Data Herewith the Weights of Other Fittings May be Calculated

All values are in pounds

Fittings	2	3	4	5	6	Size of fittings, inches: 3 by 2	4 by 2	4 by 3	5 by 2	5 by 3	5 by 4	6 by 2	6 by 3	6 by 4	6 by 5
¼ bends, regular	6¾	10¼	15	19	23½	..	..	..	..	..	..	..	..	..	..
¼ bends, short sw'p	8¼	12½	17¾	22½	27½	..	..	..	..	..	..	..	..	..	..
¼ bends, long sw'p	10¼	15¾	22	27½	33½	..	..	..	..	..	..	..	..	..	..
⅜ bends	6¼	9¾	13¾	17½	21½	..	..	..	..	..	..	..	..	..	..
1/6 bends	6	9¼	13	16½	20	..	..	..	..	..	..	..	..	..	..
⅜ bends	5½	8½	12¼	15¼	18¼	..	..	..	..	..	..	..	..	..	..
⅛ bends	5	7¾	10¾	13¼	15¾	..	..	..	..	..	..	..	..	..	..
Return bends	8¾	14	20¼	26½	33½	..	..	..	..	..	..	..	..	..	..
Tees	10¼	15¼	21	26½	32½	13¼	16½	18¾	19½	22	24½	22½	25	27½	30
Tapped tees (tapped up to 2 in.)	8¾	..	..	..	..	11¾	15	..	17¾	..	..	20½	..	..	..
Sanitary tees	11	16¼	22½	28	34½	14	17¼	19¾	20	23	25½	23	26	29	31½
Tapped sanitary tees (tapped up to 2 in.)	9	..	..	..	..	12	15¼	..	18	..	..	21¼	..	..	..
Y branch	11	17	24	31¼	39½	14	17¼	20½	20	23½	27½	23	27	31	35
½ Y branch	10¼	15½	21¾	27½	34	13½	16½	19	19½	22	25	22½	25½	28½	31
Tapped inverted Y branch (tapped up to 2 in.)	10¼	13¾	17½	21	24	..	..	..	..	..	..	..	..	..	..
Inverted Y branch	11½	18	25¼	33	41½	15	18¾	22	22	25½	29½	25½	29½	33	37
Combination Y and ⅛ bend	12	18¾	27	35	44½	15	18¼	22¼	21	25½	30½	24	29	34	39
Upright Y branch	12½	19½	28	36½	46	15¾	18¾	23	21½	26½	31½	24½	29½	35	40

Inspection and Rejection

12.—The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not

4.—(*a*) In the case of castings of special design and importance, test lugs shall be cast of a size proportional to the thickness of the castings but not exceeding ⅝ by ¾ inch in cross-section. On castings which are 24 inches or over in length, a test lug shall be cast at each end. These test lugs shall be attached to the casting at such point that they will not interfere with the assembling of the casting and may be broken off by the inspector.

(*b*) If the purchaser or his representative so desires, a casting may be tested to destruction. Such a casting shall show good, tough malleable iron.

5.—(*a*) Tension test specimens shall be of the form and dimensions shown in Fig. 1. Specimens whose mean diameter at the smallest section is less than 31/32 inch will not be accepted for test.

(*b*) Transverse test specimens shall be 14 inches in length, 1 inch in width and ¾ inch in thickness, and shall not vary more than 1/32 inch in either sectional dimension. Before the test is made, the specimen shall be center punched in accordance with Fig. 2, and after test, the deflection shall be measured as shown.

(*c*) Two tension and two transverse test specimens shall be cast from each melt, without the use of chills, with risers of sufficient height at each end to insure sound bars.

FIG. 1—FORM AND DIMENSIONS OF TENSION TEST SPECIMEN

These bars, representing the castings from each heat, shall be suitably marked to insure identification and annealed with the castings.

6.—One tension and one transverse test specimen representing each melt shall be selected for test. The remaining specimens shall be reserved and shall be tested in case of failure of the first test to conform to the requirements specified.

Sections 7 to 10 deal with details of marking castings, conforming to drawings, etc.

11.—(*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise ordered by the purchaser, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The manufacturers shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test bars cast from such melts. These records shall be available and shown to the inspector whenever required.

12.—Castings which show injurious defects subsequent to their acceptance at the manufacturer's works may be rejected, and if rejected, shall be replaced by the manufacturer free of charge to the purchaser.

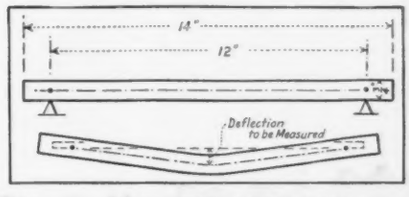

FIG. 2 — HOW THE DEFLECTION OF THE TEST SPECIMEN IS TO BE MEASURED

Presented at the annual meeting of the American Society for Testing Materials.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Baxter Stove Co., Mansfield, O., has announced its retirement from business.

The American Iron & Brass Co., Oakland, Cal., is building an addition to its plant.

The Detroit Brass Works, Retroit, will build a 5-story factory and foundry building.

The Decatur Malleable Iron Works, Decatur, Ill., will build an addition, 80 x 100 feet.

The Stafford Co., Reedville, Mass., recently completed a new gray iron foundry.

The American Machine Foundry Co., Brooklyn, N. Y., is building a 4-story plant, 120 x 150 feet.

The Kilby Mfg. Co., Cleveland, will erect a pattern shop, and a sprinkler system also will be installed.

The St. Paul Foundry Co., St. Paul, has purchased the site for the erection of a plant at a cost of $40,000.

The Monarch Foundry Co., Stockton, Cal., contemplates the erection of a machine shop, 100 x 150 feet.

The Colonial Brass Co., Middlesboro, Mass., is erecting an addition to its plant, 30 x 60 feet.

The Manhattan Brass Co., New York, has awarded a contract for the erection of a 7-story building.

The Plumbers' Woodwork Co., Algoma, Wis., is erecting a foundry addition, 30 x 50 feet.

The Ireland & Matthews Mfg. Co., Detroit, will erect a 2-story foundry building at a cost of about $20,000.

The Huntington Steel Foundry Co., Huntington, Ind., is erecting a 2-story, 40 x 80-foot addition to its plant.

The Columbus Malleable Iron Co., Columbus, O., has commenced the construction work on a $10,000 addition.

The St. Paul Foundry Co., St. Paul, is erecting a 2-story building at a cost of $12,000.

The Spring City Foundry Co., Waukesha, Wis., manufacturer of gray iron castings, is building an addition, 80 x 140 feet.

The Southern Illinois Machine & Foundry Co., Murphysboro, Ill., will build a foundry, forge and car shop, 60 x 120 feet.

The Bay State Smelting & Refining Co., Chelsea, Mass., has been incorporated with $25,000 capital by Harry Ficksman, Jacob Levendorf and G. Ficksman.

The Hershey Foundry & Machine Co., Manheim, Pa., is erecting a 50 x 300-foot pattern storage building and a 40 x 90-foot cleaning room.

The Wisconsin Aluminum Foundry Co., Manitowoc, Wis., is installing six additional furnaces and is building an addition, 30 x 190 feet.

The Bay View Foundry Co., Sandusky, O., is building an addition to its plant, 60 x 120 feet, which will be devoted to the cleaning of castings.

The Atlas Crucible Steel Co., Dunkirk, N. Y., is erecting a producer gas plant. Additions to its melting department recently were completed.

The Whitney-Mead Commercial Co., Los Angeles, Cal., will erect a plant, 110 x 210 feet, for the manufacture of cast iron sanitary enamel and hollowware. The initial plant, when equipped will cost $50,000.

The Superior Iron & Steel Corp., has been incorporated at Wilmington, Del., with $3,000,000 capital to engage in the operation of an iron foundry. The incorporators are H. G. Eastburn, Artemus Smith and M. R. Doto.

The plant of the Marietta Agricultural Works, Marietta, Pa., which has been idle for a number of years, has been sold to the Pittsburg Brass & Iron Foundry, which will remodel the works and place them in operation.

The Standard Foundry Co., New Kensington, Pa., recently was organized with a capital of $50,000 and will engage in the operation of a jobbing gray iron foundry. The officers follow: Horton Penrose, president; M. F. Christian, vice president, and W. G. Kenney, secretary and treasurer.

The Mishawaka Brass Foundry Co., Mishawaka, Ind., is the firm name of the company succeeding the South Bend Brass Foundry & Machine Co. A specialty is made of brass, bronze, aluminum and white metal castings. The officers of the company follow: George H. Thayer Jr., president; W. H. Young, treasurer; P. M. Thayer, secretary, and James J. MacGuire, superintendent.

The Beckemyer Foundry Co., has been organized at Beckemyer, Ill., with $8000 capital to engage in the operation of a foundry for the production of gray iron, semisteel, brass and aluminum castings. A plant, 60 x 100 feet, now is being erected. The incorporators are H. O. Briefield and W. L. Timmons. W. G. Keller has been appointed general manager and superintendent.

The new plant of the Ecorse Foundry & Machine Co., Ecorse, Mich., has been placed in operation. It is equipped to manufacture light gray iron castings and has a capacity to melt 100 tons of iron daily. The officers of this company follow: B. F. Everitt, president; W. A. C. Miller, vice president, and A. J. Kinnucan, treasurer and general manager.

New Construction

The Perkins Foundry Co., Inc., Amsterdam, N. Y., has increased its capital from $20,000 to $50,000.

The Industrial Foundry & Machine Co., Pottstown, Pa., has completed an addition to its plant, 50 x 135 feet.

The Bedford Foundry & Machine Co., Bedford, Ind., is erecting an addition to its foundry, 50 x 80 feet.

The Arcade Malleable Iron Co., Worcester, Mass., is building a foundry addition, 75 x 150 feet, at a cost of $12,000.

Southard, Robertson & Co., Peekskill N. Y., will erect a 2-story stove plant at a cost of $35,000.

The Atlas Crucible Steel Co., Buffalo, is building a transformer house and laboratory building, 30 x 76 feet and 32 x 62 feet.

The Rockford Union Foundry Co., Rockford, Ill., has been incorporated with $25,000 capital, by H. L. Olson, W. A. Brolin and Shelby L. Large.

The Camden Foundry Co., Camden, Ark., whose plant recently was destroyed by fire, has completed a new fireproof building for its shop.

The Woodward Foundry & Machine Co., Woodward, Okla., has been incorporated with $25,00 capital, by Charles H. Martin, Henry Hageman and William H. Smith.

The Standard Brass Tube Co., New London, Conn., recently taken over by the Bridgeport Brass Co., will build two additions to its foundry, 65 x 150 feet and 45 x 65 feet, respectively.

The Gallison Brass Foundry, Lawrence, Mass., has been incorporated with a capital stock of $5000. The directors are P. C. Wiggin, president; Francis B. Mowry, treasurer, and William Gallison.

The Mal-Gra Castings Co., which recently removed its sales office from Cincinnati to Middletown, O., states that it will not remove its foundry from Cambridge City, Ind., to Middletown, as reported.

The Wheel & Foundry Co., Ltd., Ont., has ben incorporated with $25,000 capital, by Arthur J. Thompson, 132 Balmoral avenue; William S. Morelock, 107 Roxborough street, west and R. H. Permenter.

The Dominion Foundries & Steel, Ltd., Hamilton, Ont., has been incorporated with $6,000,000 capital to take over the business now operated by the Dominion Steel Foundry Co.

The American Locomotive Co., New York, has purchased from the Penn-Seaboard Steel Casting Corp., the Seaboard Steel Castings Co.'s plant at Chester, Pa., which has a capacity of about 18,000 tons of steel castings annually.

The Pelton Steel Co., Milwaukee, is installing a 3000-pound Snyder electric furnace which duplicates the original installation of this equipment. The present schedule of five heats daily, is to be increased to seven, the two furnaces to be used alternately.

The Glover Machine Works, Atlanta, Ga., will install an electric melting and refining furnace to be furnished by the John A. Crowley Co., Detroit. The foundry building, which already has been erected, will be commanded by a 40-foot crane of 15 tons capacity.

The Glover Machine Works, Marietta, Ga., will install an electric furnace for the manufacture of steel castings as well as a forge shop and such equipment as steam hammers, sand-blast machinery, grinders, sand mixing machinery, etc., now is being purchased. A specialty will be made of the manufacture of industrial locomotives.

The Central Texas Iron Works, Waco, Tex., has been organized with $26,000 capital and will erect a plant for the manufacture of gray iron castings, the fabrication of structural steel and the building of a cast canning furnace. F. A. Winchell is president, Jas. T. Stubbs, vice president and Oliver Winchell, secretary.

The foundry of the Ames Plow Co., Framingham, Mass., is to be enlarged in the near future. It is the intention to devote this plant to the manufacture of heavy castings, some of which now are being made by the Woonsocket Machine & Press Co., Woonsocket, R. I., an allied concern. The Woonsocket company's foundry, when the change is made, will be devoted entirely to the production of castings for light textile machinery.